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1903.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 10.

PALÆONTOLOGICAL CONTRIBUTIONS
TO THE
GEOLOGY OF WESTERN AUSTRALIA.

I.

DESCRIPTIONS OF CARBONIFEROUS FOSSILS FROM THE CASCOYNE DISTRICT, WESTERN AUSTRALIA,

BY

R. ETHERIDGE, Junr.,
Curator of the Australian Museum, Sydney, N.S.W.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

PERTH:
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1903.

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PREFATORY NOTE.

THE Carboniferous rocks of the Gascoyne District form part of a very extensive formation which covers a wide area of country in Western Australia, and which bids fair to become of considerable economic importance.

These rocks have been traced, with a few minor interruptions, across the valleys of the Wooramel, the Murchison, the Greenough as far south as the Irwin River, where coal seams outcrop; and to the northwards across the Minilya, the Henry, the Ashburton, and the Fortescue Rivers. Near the head of this latter river they disappear under the desert, and on emerging cover a wide stretch of country in the Kimberley Division.

In the Gascoyne District the beds consist of sandstones, shales, limestones, and conglomerates. Near the base of the series is a well-marked boulder bed, showing undoubted evidences of glacial origin. The boulder bed is made up of a heterogeneous collection of all varieties of crystalline rocks, together with many very large flat-sided boulders of granite. This bed, which forms a very valuable stratigraphical horizon, has been traced across country for a distance of about 60 miles.

The Carboniferous rocks of the Gascoyne, although arranged in a series of gentle folds, have a prevailing dip to the West. The thickness of the series cannot at present be ascertained, though the bore now being put down at Pelican Hill, near Carnarvon, at the mouth of the Gascoyne, has shown it to be at least 1,600 feet thick.

Fossils are of such importance in determining the relative age, succession, and correlation of strata that the investigation of the Palæontology of a formation becomes an important factor in the early attempts at the development of the mineral resources of a region in which the stratigraphy has been but imperfectly worked out.

The Geological Survey is indebted to Mr. Robert Etheridge, Junr., Curator of the Australian Museum, Sydney, for assistance rendered gratuitously in the determination and description of fossils which have been submitted to him from time to time and for the Palæontological Contributions to the Geology of the State, which form the subject matter of this report.

The illustrations by which Mr. Etheridge's descriptions are accompanied are the work of Messrs. F. R. Leggatt and E. R. Waite, and bear evidence of the care which has been bestowed upon them.

On being submitted to the Hon. the Minister for Mines, Mr. Etheridge's report was ordered to be printed for public information.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Beaufort Street,
Perth, 10th July, 1903.

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Descriptions of Carboniferous Fossils from the Gascoyne District, Western Australia, collected by Mr. A. Gibb Maitland, Government Geologist,

BY

R. ETHERIDGE, Junr.,

Curator of the Australian Museum, Sydney, N.S.W.

I.—Introduction.

The fossils recorded in the following pages were transmitted to me for description by Mr. A. Gibb Maitland, Government Geologist of Western Australia, and were collected by him and his colleague, Mr. H. W. B. Talbot, Field Assistant.

The following are the localities:—

(1.) Wandagee Station, Minilya River.
(2.) Coolkilya Pool, Wandagee Station.
(3.) Wandagee Hill, Minilya River.
(4.) Williambury Station, Minilya River.
(5). Hills on the Western boundary of No. 4.
(6.) Well 20, Daurie Creek, Gascoyne River. Shale with microscopic and interesting fragments of Polyzoa.
(7.) Trig. Station, K. 37, Gascoyne River. Sandstone series.
(8.) Fossil Hill, Wyndham River, Gascoyne District.
(9.) Wyndham River. Boulder Bed.
(10.) Gascoyne River.
(11.) Baracooda Pool, Arthur River.

The facies of the fossils is purely Carboniferous.

I have added some notes on a most interesting occurrence of Endophytic Fungi, in swollen Crinoid stems, and in the visceral chambers of two species of *Hexagonella*. These specimens have afforded me a far more intimate knowledge of the infesting nature of these peculiar organisms than any previous forms playing the part of "host" that have come under my notice. I wish to take this opportunity to explain the use of the word endophytic. An endophyte is a plant which grows inside another, and, strictly speaking, the term is not applicable in the present and other instances previously cited by me, from the simple fact that we have a low form of plant life within the tissues and visceral cavities of animals. On the other hand, the term endophytic is a convenient one to express the habit of the intruding organism, and only in this sense is it used by me.

II.—Description of the General Collection.

PLANTÆ.

Obs.—The imperfect specimen represented in Plate I., fig. 1., is possibly the impression of a Fucoid, and may be referred to *Chondrites*, Sternberg. From the appearance of the specimen there would seem to have been a central stalk, giving off lateral branches, and the latter short filaments. All that remains is a carbonaceous impression.

Loc.—Wandagee Station, Minilya River.

ACTINOZOA.

GENUS AMPLEXUS, *J. Sowerby*, 1814.

(Mineral Conchol., 1814, i., p. 165).

AMPLEXUS PUSTULOSUS, *Hudleston.*

Amplexus pustulosus, Hudleston, Quart. Journ. Geol. Soc., 1883, xxxix., p. 591, t. 23, f.1. *a-c.*

Amplexus pustulosus, Hinde, Geol. Mag., 1893, vii. (3), p. 194.

Obs.—This species is represented in the collection by a portion of a corallum one and three-quarter inches long, and with a compressed diameter of one and a half inches. It is devoid of epitheca, and exhibits the broad flat costæ, two millimetres wide, as in Dr. Hinde's figure, with short septa, two millimetres apart, and wide flat tabulate area. There are, approximately, forty costæ, and externally the septa are represented as flat longitudinal grooves.

Loc.—Williambury Station, Minilya River.

GENUS PLEUROPHYLLUM, *Hinde*, 1890.

(Geol. Mag., 1890, vii. (3), p. 195).

PLEUROPHYLLUM AUSTRALE, *Hinde.*

Pleurophyllum australe, Hinde, Geol. Mag., 1890, vii. (3), p. 196, t. 8a., f.1. *a-f.*

Loc.—Williambury Station, Minilya River; Fossil Hill, Wyndham River.

GENUS HEXAGONELLA, *Waagen and Wentzel*, 1886.

(Salt Range Foss. (Pal. Ind.) 1886, i., Pt. 6, p. 911).

HEXAGONELLA DENDROIDEA, *Hudleston, sp.*

Evactinopora dendroidea, Hudleston, Quart. Journ. Geol. Soc., 1883, xxxix, p. 594, t. 23, f. 3 *a-d*.

Hexagonella dendroidea, Waagen and Wentzel, Salt Range Foss. (Pal. Ind.), 1886, i., Pt. 6, p. 913.

Hexagonella dendroidea, Hinde, Geol. Mag., 1890, vii. (3), p. 200, t. 8, f. 6, t. 8a., f. 5 *a-d* (exclude Etheridge's ref.).

Obs.—Hinde remarks that Waagen and Wentzel believed *Hexagonella* to possess "a mode of increase by so-called cœnenchymal gemmation," but that he could "find no indication of this alleged cœnenchymal growth, but, on the contrary, a mode of growth from a basal lamina." Again, Dr. Hinde adds:—"The centre of the branches has a median lamina extending from end to end, from which the cells are given off. This axial lamina is double in character; in their sections it appears as a dark line with a layer of lighter material on either side of it." From independent examination, I am able to confirm the whole of Hinde's observations, so far as *H. dendoridea* is concerned, as well as the general accuracy of his description of this interesting form. Under these circumstances, it is quite unnecessary to re-describe it.

Loc.—Fossil Hill, Wyndham River.

HEXAGONELLA (?) CRUCIALIS, *Hudleston, sp.*

(Plate III., fig. 1.)

Evactinopora crucialis, Hudleston, Quart. Journ. Geol. Soc., 1883, xxxix., p. 593, t. 23, f. 2 *a-c*.

Evactinopora crucialis, Eth. fil., Proc. Linn. Soc. N. S. Wales, 1889, iv. (2), p. 207.

Obs.—On this fossil, Dr. Hinde remarked:—"It appears to me very doubtful whether the form named *H.* (*Evactinopora*) *crucialis*, Hudleston, is really distinct from *H. dendroidea*; as the difference consists merely in the mode of growth, a feature hardly of sufficient importance." I had previously expressed a somewhat similar opinion,* but the examination of additional material has caused me to modify this view. So far, I have never seen on the exterior of *H.* (*?*) *crucialis* polygonal spaces bounded by ridges as in *H. dendroidea*, but of course this may only be due to the state of preservation. The internal structure of the two supposed forms is precisely similar, even to the presence of the recumbent cells on a basal lamina in *H.* (*?*) *crucialis*. On the other hand, the transverse diameter of the autopores is less in the latter, being ·2 to ·24 mm., as against ·2 to ·25 mm. in *H. dendroidea*. The distance of the tabulæ apart in the autopores of *H. dendroidea* is less than in *H.* (?) *crucialis*; in the former it is ·5 mm., and in the latter ·8mm.

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* Proc. Linn. Soc. N. S. Wales, 1889, IV. (2), p. 207

In *H.* (?) *crucialis* the mode of growth is constantly cruciform, that of the other bifurcate, and therefore presumedly branching. Other minor differences can also be detected, such, for instance, as the different sectional outline in the two forms.

H. (?) *crucialis* is both quadri-and pentaradiate. This cruciform mode of growth is precisely that of *Evactinopora*, M. and W.,* but unfortunately we at present know so little of the internal structure of the American genus that it is unsafe to replace the name *Hexagonella* by that of *Evactinopora.* This step, however, will become necessary if future research should reveal a similar anatomy in the types of the two forms. Messrs. Waagen and Wentzel, the authors of *Hexagonella*, appeared to be very undecided in their opinion at the time they wrote. So far as my present knowledge permits me to judge, I believe the American and Indo-Australian forms will prove to be one and the same generically.

Dr. Hinde credits me, in his synonymy of *H. dendroidea*, with a reference to that species. In my paper on the late Sir W. Macleay's Kimberley fossils, I did not refer to this species, but distinctly to *Evactinopora crucialis*, Hudleston.

Loc.—Fossil Hill, Wyndham River.

ANNELIDA.

GENUS SPIRORBIS, *Lamarck*, 1818.†

(Hist. Anim. sans Vertèb., 1818, v., p. 358.)

SPIRORBIS AMBIGUUS, *Fleming*.

(Plate III., fig. 2.)

Spirorbis ambiguus, Fleming, Edinb. Phil. Journ., 1825, xii., p. 246, t. 9, f. 3.

Spirorbis ambiguus, Eth. fil., Geol. Mag., 1880, vii. (2), p. 258, t. 7, f. 9.—11.

Obs.—One example of this little cosmopolitan Tubicolar Annelid is present adhering to a value of *Cliothryis macleayana*, Eth. fil. I believe this to be the first record of a Carboniferous *Spirorbis* in Australia, unless the specimen mentioned by Dr. G. J. Hinde as *S. omphalodes*, Goldf.‡ be it. The horizon given by the latter is Devonian, and the locality Gascoyne River, from whence I have never seen other than Carboniferous fossils.

The present shell is dextral, with an open umbilicus, and the aperture, although a little broken, seems to have been produced. The sculpture is not retained.

Loc.—Fossil Hill, Wyndham River.

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* Meek and Worthen, Proc. Acad. Nat. Sci. Philadel., 1865, p. 165; Illinois Geol. Survey Report, 1868, III., Pt. 2, p. 501.

† Eth. fil, restricted 1890. Geol. Mag., 1880, vii. (2) pp. 112 and 258.

‡ Geol. Mag., 1890, vii. (3), p. 199.

CRUSTACEAN (?) TRACKS.

Obs.—Plate I., fig. 2, is probably only a fragment of a very much larger specimen. It consists of nine nodular or sub-moniliform bodies separated by transverse depressions, the whole forming a curved body five inches in length. The under surface is simply rounded, whilst on both the convex and concave faces is a continuous projecting ridge; the nodules are three-eighths of an inch long by five-eighths wide. It is simply a cast in sandy, slightly micaceous shale, without the slightest trace of test or organic covering.

Much speculation and a good deal of controversy has at times taken place as to the real nature of what are generally known as "tracks and markings." In the present instance, however, a tolerably satisfactory explanation can be given. Almost identical tracks were described * by Mr. Albany Hancock from the Carboniferous sandstones of the North of England. He remarked:—"Full-sized specimens are half an inch wide, and are composed of a series of nodules . . . . , which give them an articulated appearance. The nodules, which vary a little in size, are usually about half an inch long, and are not very symmetrically or regularly formed; consequently the surface has generally an imperfect or worn character."

Mr. Hancock offered the following explanation:—Whilst walking on the beach sand at Cullercoats, Northumberland (Engl.), he observed a flat, ribbon-like track, occasionally several feet in length, winding in an intricate manner, and frequently and irregularly convoluted, "forming, as it were, loose knots or systems in which neither the commencement nor the termination can be easily detected . . . . The tracks also occasionally show enlargements placed at some little distance from each other.†" On watching, he says that the sand at one of the extremities was observed to be gently agitated; and on this agitation ceasing, the track was found to have added nearly half an inch to its length. "In the course of two or three minutes the sand was again put in motion, and the track once more a little prolonged. These movements were repeated over and over again, until it was quite clear that the tracks were formed by slow, intermitting steps, and not, as might have been supposed, by one continuous gliding motion. Having satisfied myself of this, I took up the morsel of sand at the end of the track, just as it was again becoming agitated, and found that I had captured a small crustacean. . . . . It was undoubtedly one of the Amphipoda."‡ He further adds that whilst forming its track the animal is never seen. The Crustacean thus captured was subsequently described by Mr. C. Spence Bate as *Kroyera arenaria*. A second form was also taken at the same time, named by Mr. Bate *Sulcator arenarius*. When the latter was "placed in a shallow vessel with the bottom thickly covered with sand moistened with sea-water, so as to resemble as nearly as possible the state of the beach . . . it thrust itself through the surface of the sand, and, sinking immediately again, left there an oval swelling; and repeating the action five or six times formed a series of nodules, which, if continued, would have produced a track of a peculiar articulated appearance." *

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* Ann. Mag. Nat. Hist., 1858, ii. (3), p 448, t. 16, 17. † Ann. Mag. Nat. Hist., 1858, ii. (3), p. 445. ‡ Ann. Mag. Nat. Hist., 1858, ii. (3), p. 446.

Mr. Hancock's article is well worth the perusal of those interested in the formation of tracks, and, without wishing to imply that the track now under consideration was formed by an Amphipod, of which, so far as I know, no trace has been found in the West Australian Carboniferous beds, yet the resemblance to the tracks of the two species named is so marked that the possibility exists; at any rate the identity of the track now figured with those from the North of England Carboniferous cannot be gainsaid. In the words of Mr. Hancock, "It may, therefore, be assumed that the animal which made these nodulous tracks, like our little crustaceans, pushed along in its path step by step, resting awhile after each advance; but that, instead of moving in the same horizontal plane, it alternately rose and sank a little; consequently a series of nodules were produced, and the track acquired its peculiar articulated appearance." † An alternative suggestion was to the effect that these tracks might be the runs of Trilobites. It would be quite possible to offer other explanations, but at present our knowledge of these obscure markings is so circumscribed that little out of the realm of speculation can be advanced.

Loc.—Coolkilya Pool, Wandagee Station, Minilya River.

BRACHIOPODA.

GENUS SPIRIFERA, *J. Sowerby*, 1816.

(Mineral Conchol., 1816, ii, p. 41.)

SPIRIFERA MUSAKHEYLENSIS, *Davidson.*

Spirifera Moosakhailensis, Davidson, Quart. Journ. Geol. Soc., 1862, p. 28, t. 2, f. 2 a-c.

Spirifer Moosakhailensis, De Koninck, Mém. Soc. Sci. Liege, 1863, xviii.

Spirifer Moosakhailensis, Beyrich, Abhandl. K. Akad. Wiss. Berlin, 1864 (1865), xxxvi., p. 77, t. 1, f 7.

Spirifera Moosakhailensis, Davidson, Quart. Journ. Geol. Soc., 1866, xxii., p. 41, t. 2, f. 6.

Spirifera Moosakhailensis, Eth., fil., Cat. Austr. Foss., 1878, p. 57.

Spirifer timorensis, Martin, Samml. Geol. Reichs-Mus. Leiden, 1881, i. (1), p. 41, f. 7, 7*a* and *b*, 8.

Spirifera Musakheylensis, Waagen, Salt Range Foss. (Pal. Ind.), 1883, i., Fas. 4, No. 2, p. 512, t. 45.

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* Ann. Mag. Nat. Hist., 1858, ii. (3), p. 447.

† Ann. Mag. Nat. Hist., 1858, ii. (3), p. 450.

Spirifera Musakheylensis, var. *australis*, Foord, Geol. Mag., 1890, vii. (3), p. 147, t. 7, f. 2, Pt. 5, f. 12.

Spirifer fasciger, Schellwien, Palaeontographica, 1892, xxxix., Lief. 1, p. 42, t. 5, f. 3 (*non* f. 2).

Spirifer Musakheylensis, Rothpletz, Palaeontographica, 1892, xxxix., Lief. 2 and 3, p. 79, t. 9, f. 1 and 2.

Spirifer Musakhleycnsis, Deiner, Himalayan Foss. (Pal. Ind.) 1897, i., Pt. 3, p. 43, t. 6, f. 8; *Ibid.* Pt. 4, p. 35, t. 3, f. 3 and 4, t. 4, f. 1*a* and *b* and 2, t. 5, f. 1; *Ibid.* 1899, Pt. 2, p. 63, t. 5, f. 3-7.

[Compare—

Spirifer fasciger, Keyserling, Reise in das Petschoraland, 1843, p. 229, t. 8, f. 3, 3*a*, *b*.

Spirifer tegulatus, Trautschold, Kalkbrüche von Mjatschkowa, 1876, Pt. 2, p. 80, t. 8, f. 6 *a-g*.

Spirifer fasciger, Tschernyschew, Mém. Com. Géol. Russ., 1889, iii., Pt. 4, p. 366, t. 5, f. 4*a-c*.]

Obs.—I have examined several specimens of this widely-distributed species, and although adopting Davidson's specific name, I cannot divest myself of the belief that Keyserling's *S. fasciger* and Trautschold's *S. tegulatus* are identical. At the same time, it would be presumptuous on my part to pit my opinion one way or the other against that of those with opportunities of examining examples of all the so-called species. Whether the views of Messrs. Tschernyschew, Nitikin * and Schellwien † on the one hand, or those of Messrs. Waagen and Diener on the other, be correct, can only be settled by assembling a large series of all the various forms for comparison, and in particular a comparison of the internal characters. Whether or no *S. tegulatus* be identical with Davidson's species, will not cause any alteration in nomenclature, for this name was not proposed until some years after the former, but in the event of *S. fasciger* being found identical, Davidson's name must be relegated to the synonymic list.

The prominence of the fasciculi of costæ, and the number of costæ comprised in a fasciculus is open to great variation in our Australian shells, even in specimens from the same locality. The degree of preservation of the "sharp, projecting, concentric, undulating laminæ" (frills would be a better term), is also very variable. In one specimen before me the fasciculi are not only very prominent and angular, but the concentric frills are more prominent and upstanding on the cardinal half of the valve than they are on the fore, or ventral half, where they become more strictly of the nature of laminæ. Again, our shells developed few and wide-apart lati-laminæ, as in some of the Indian example of the species.

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* Mém. Com. Géol. Russ., 1890, v., No. 5, p. 164. † Zeits. Deuts. Geol. Gesellschaft, 1894. xlvi., 1 Heft, p. 72.

All the specimens both of this and the following species are, with one exception, ventral valves. The latter is a small individual imbedded in matrix, but from its outline appears to be *S. musakhleyensis*. In this the area is proportionately narrow, and without subdivision, concave and denticulated, and oblique to the general plane of the valve. The delthyrium is wide, with well-marked deltidial grooves. The dental sockets are triangular and without grooves, extending backwards to the cardinal process or boss; the latter is somewhat flattened and vertically grooved.

Loc.—Fossil Hill, Wyndham River.

SPIRIFERA HARDMANI, *Foord.*

(Plate I., figs. 6 & 7; Plate II., figs. 7-9.)

Spirifera Hardmani, Foord, Geol. Mag., 1890, VII. (3), p. 146, t. 7, f. 1, 1*a*.

Obs.—I believe I have before me several specimens of the Spirifer described under this name by Mr. Foord, but whether it is a stable species is open to doubt. The ill-defined folds of the lateral rounded areas of the ventral valve, described by Foord, are quite recognisable, and are suspiciously like some of the fasciculate bundles of costæ in *S. musakheylensis*. There exists, however, it may be a very trivial but at the same time well-marked difference in the surface characters of the two shells. In the present form, the lati-laminæ commence close to the umbo and rapidly succeed one another, becoming closer and closer as the front of the valve is approached, and on crossing the sulcus the lati-laminæ take a sharp V-shaped dip forwards. In Davidson's species, judging from Waagen and Diener's figures, the lati-laminæ are variable in position and distance apart, and on crossing the sulcus form a very open and wide V-shaped figure.' The surface of *S. Hardmani*, when well preserved, is very delicately frilled, the frills pressed on the surfaces of the lati-laminæ.

The area is moderately wide and without subdivision, concave transversely (*i.e.*, at a right angle to the plane of the valve), lined or stepped to correspond with the lati-laminæ, and over all longitudinally striated. The delthyrium is large and widely triangular, with well-marked deltarial grooves and prominent, stout teeth.

Mr. Foord suggests a reference to this species of that portion of a shell figured by me from Queensland as *S. trigonalis* var. *crassa*, De Kon. (?).* He may be correct, but the specimen is in too bad a state of preservation to enable one to arrive at a satisfactory conclusion.

Loc.—Fossil Hill, Wyndham River.

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* Geol. Pal. Q'land, 1892, p. 230, t. 11, f. 5.

SPIRIFERA LATA, *McCoy.?*

(Plate I., fig. 8.)

Spirifera lata, McCoy, Ann. Mag. Nat. Hist., 1847, xx., p. 233, t. 13, f. 7.

Spirifer latus, De Koninck, Rech. Pal. Foss. Nouv.-Galles du Sud, 1877, Pt. 3, p. 106.

Spirifera lata, Eth. fil., Cat. Austr. Foss., 1878, p. 56.

Spirifera lata, Foord, Geol. Mag., 1890, vii. (3), p. 145, t. 6.

Obs.—McCoy described and figured this species from an internal cast, in which the ventral sulcus and alar angles were devoid of costæ. Mr. Foord copied McCoy's description, but figured a fine slab of valves in different stages of preservation. Some unquestionably display the sulcus devoid of ribs, others are not so definite, as the sulci appear to be occupied by one or more costæ. I now figure a ventral valve which may be that of *S. lata*, although I apply the name with reluctance, differing from that species by a costate sinus, but at the same time with the extended and nearly smooth alations, otherwise characteristic of it. The costæ are crossed by fine, delicate, flat, concentric frills, like those of the *S. mucronata* group. The area is moderately wide, and gently concave at right angles to the general plane of the valve.

I believe this to be a variety of *S. lata*, McCoy. The latter is a very rare form in the Carboniferous and Permo-Carboniferous rocks of Eastern Australia. It appears to be a close ally of *S. alata*, Schl., a Permian species, also occurring in the Indian Salt Range Series, and devoid of costæ on the wings.

The more or less spindle-shaped outline also places this shell near *S. convoluta*, Phill., but in the latter both the wings and sulcus are costate, although the latter not to the same extent as in the specimen now provisionally referred to *S. lata*.

Loc.—Fossil Hill, Wyndham River.

SPIRIFERA, *sp. ind.*

(Plate I., fig. 9; Plate II., fig. 6.)

Obs.—A single dorsal valve of an alate Spirifer accompanies the last specimen. It possesses numerous gently convex, entire regular costæ, not united into bundles or fasciculi of any kind, but fading away on the wings, although not to the same extent as in *S. alata*, and crossed by close concentric lines.

The area is moderately wide and vertical—*i.e.* in the same plane as the valve. The cardinal process is large, round, and vertically striate; the cardinal sockets long, groove-like above, and expanded at their outer terminations; the crural bases sharp, upstanding, and separated from the cardinal process by deep grooves (the deltidial grooves) running alongside the dental sockets, and their downward and forward extensions much thickened. There is no trace of denticles along the area; the cavity of the muscular impressions is deep and narrow.

This valve has some points of close resemblance to the alate varieties of *S. Lydekkeri*, Diener,* but the material at my disposal is of too limited a nature to enable me to institute a close comparison. I must, however, dissent from Mr. Diener's opinion that his species resembles our Permo-Carboniferous *S. Clarkei*, De Kon. It appears to me that the two are much more widely separated than he supposes.

Loc.—Gascoyne River.

GENUS RETICULARIA, *McCoy*, 1844.

(Synop. Carb. Lime. Foss. Ireland, 1844, p. 142.)

RETICULARIA LINEATA, *Martin, sp.*

Spirifera lineata (Martin), Davidson, Mon. Brit. Carb. Brach, 1858, Pt. 5, p. 62, t. 13, f. 1–13.

Reticularia lineata, Foord, Geol. Mag., 1890, vii. (3), p. 153.

Obs.—Mr. Foord recorded this widely distributed shell from the Irwin River. Mr. Maitland collected examples of the ventral valve from the locality given below, displaying the principal features of the species.

Loc.—Fossil Hill, Wyndham River.

GENUS CLEIOTHYRIS, *King*, 1850.†

(Mon. Perm. Foss. England, 1850, p. 137.)

CLEIOTHYRIS MACLEAYANA, *Eth. fil. sp.*

(Plate III., figs. 10–20.)

Athyris macleayana, Eth. fil., Proc. Linn. Soc. N.S. Wales, 1889, iv. (2), p. 208, t. 17, f. 1–5.

Athyris macleayana, Foord, Geol. Mag., 1890, vii. (3), p. 149, t. 7, f. 3, p. 150, f. B & C (*non* f.A.).

Obs.—A very fine series of this interesting shell was obtained by Mr. Maitland at two localities.

The suspicion originally expressed by me that the concentric laminæ of the exterior extended into free spines, as in *Cleiothyris Roysii*, Lev., sp., was confirmed by Mr. Foord, and the shell is, therefore, removed to that genus. Some of the specimens now before me exhibit this feature much more distinctly than did those in the Macleay collection, and even when the surface is worn the spines can often be detected along the immediate edges of the laminæ; they are occasionally very much thickened in the pedicle valve. In a few instances the transversely oval outline gives place to a longitudinally oval one, and much variability is also observable in the degree of convexity of the dorsal or brachial valve.

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* Himilayan Foss. (Pal. Ind.), 1897, I., Pt. 2, t. 3, f. 1, 7, 8.

† *Non* Phillips, 1841.

Mr. Foord figured the interior of the ventral valve, and I have several specimens before me equally well preserved. I have not seen bifid teeth, but the most perfect individual displays the teeth hooked or recurved, as in *Athyris* proper. The hinge plate of the brachial valve is thick, and the internal opening of the visceral foramen large, but the median lobe of the hinge plate does not seem to have been extended forwards; the bases of the crura were thick and solid. The degree of depth of the adductor scars in the pedicle valve and their extension forwards are subject to much variability, and in consequence the septum separating the adductor impressions is also variable in length. In very few specimens is the septum as well marked as in Foord's Fig. C, and in all interiors examined by me the diductor (cardinal) impressions are much wider, or more oval, than shown in the same illustration, although they always terminate below in lobes, as described by Foord.

In the brachial or dorsal valve the united adductors form a long oval scar, the anterior pair somewhat leaf-shaped, the posterior rather sagittate, with the dual points forward, and a strong intervening septum; the vascular markings cover the remainder of the interior surface.

Loc.—Fossil Hill, Wyndham River; Hills on the west boundary of Williambury Station, Minilya River, Gascoyne River.

CLEIOTHYRIS MACLEAYANA, VAR. BARACOODENSIS *var. nov.*

(Plate III., figs. 5–9.)

(?) *Athyris macleayana*, Foord, Geol. Mag., 1890, vii. (3), p. 150, f. A. (*non* figs. B & C).

Obs.—At the undermentioned locality a well-marked variety of *C. macleayana* occurs to the exclusion of the typical form of the species. The convexity of the pedicle valve of the variety is relatively greater, the appearance on the latter of an incipient sinus, and the much greater transverse width of both valves are features that at once separate it from the species in chief. The valves to some extent loose the characteristic ovate-triangular outline of *C. macleayana*, but all other characters are the same. One of Mr. Foord's figures of the latter resembles it to some extent, and may possibly be identical.

Loc.—Baracooda Pool, Arthur River.

GENUS SEMINULA, *McCoy*, 1844.

(Synop. Carb. Lime. Foss. Ireland, 1844, p. 158.)

SEMINULA, *sp. ind.*

(Plate I., fig. 5; Plate III., fig. 21.)

Obs.—A single example of the united valves, not wholly free from matrix, may be referred to this genus. The valves are biconvex, elongately oval in form, the ventral with a slight median sinus, and an over-curved umbo, which I believe was perforate. It displays rough lati-laminæ, and the test was impunctate. It conveys to the eye a shell of the *Seminula subtilita*, Hall, sp. type, rather than that of either the *S. ambigua* Sby. sp., or *S. trinuclea*, Hall, sp. groups.

Loc.—Baracooda Pool, Arthur River.

GENUS ORTHOTETES, *Fischer de Waldheim*, 1829.

(Bull. Soc. Imp. Nat. Moscou, 1829, p. 375.)

ORTHOTETES CRENISTRIA, *Phillips, sp.*

Streptorhynchus crenistria (Phill., sp.), Davidson, Mon. Brit. Carb. Brach., Pt. 4, 1861, p. 124, t. 26, t. 27, f. 1.

Orthotetes crenistria, Eth. fil., Cat. Austr. Foss., 1878, p. 50.

Orthotetes crenistria, Foord, Geol. Mag., 1890, vii. (3), p. 154.

Obs.—Two portions, one that of a dorsal valve, of this cosmopolitan species, are present associated with *Productus tenuistriatus*, De Vern. (?). Foord records it from the Irwin River, Victoria District.

Loc.—Fossil Hill, Wyndham River.

GENUS PRODUCTUS, *J. Sowerby*, 1814.

(Mineral Conchol., 1814, i., p. 153.)

PRODUCTUS SEMIRETICULATUS, *Martin, sp.*

(Plate II., figs. 3-5.)

Productus semireticulatus (Martin, sp.), Davidson, Mon. Brit. Carb. Brach., Pt. 4, 1861, p. 149, t. 43, t. 44, f. 1-4.

Productus semireticulatus, Beyrich, Abhandl. K. Akad, Wissensch. Berlin, 1865, xxxvi., p. 82, t. 2, f. 1, 2*a-c*.

Productus semireticulatus, Meek, Final Report U.S. Geol. Survey Nebraska, Pt. 2, 1872, p. 160, t. 5, f. 7*a* and *b*.

Productus semireticulatus, Meek, Report U.S. Geol. Explor. 40th Par. (King's), 1877, iv., Pt. 1, p. 69, t. 7, f. 5.

Productus semireticulatus, Eth. fil., Cat. Austr. Foss., 1878. p. 53.

Productus semireticulatus, Kayser, Richthofen's China, Pt. 8, 1883, p. 181, t. 25, f. 1-4.

Productus semireticulatus, Waagen, Salt Range Foss. (Pal. Ind.), 1884, i., Pt. 4, Fas. 4, p. 679, p. 680, f. u. & *c*.

Productus semireticulatus, Diener, Himilayan Foss. (Pal. Ind.), 1897, i., Pt. 3, p. 18, t. 2, f. 1, 3, 5, t. 3, f. 1 & 2.

Obs.—I think there can be very little doubt that the shells represented in Plate II., figs. 3-5, are forms of this widely-distributed species. I am acquainted with four specimens in various conditions of preservation. They belong to the transversely oval variety represented by Davidson's Plate 43, figs. 1 and 2, with the hinge line practically as wide as the shell, the visceral region of the ventral valve well vaulted and traversed by a sinus rather wider than is usually seen in this species; the auriculate expansions largely developed, the costæ rather coarse, bearing spine bases both on the body of the shell and the wings. The decussation of the visceral regions both in the dorsal and ventral valves of the West Australian *Producti* is remarkably prouounced, resembling an illustration of this species given by De Koninck.[*] They approach generally to the Himalayan form figured by Diener, both in outline, costation, and decussation, but the costæ in the latter are more plentifully supplied with broken spine bases.

Mr. E. Schellwien[†] has described a variety of this well-known species as var. *bathykolpos* from the Alpine Fusulina Limestone, in which the ventral sinus is wider, deeper, and more pronounced than is usually the case, indicating a strong alliance with our form.

Loc.—Williambury Station, Minilya River; Baracooda Pool, Arthur River; and Gascoyne River.

The specimens from the first and second localities were collected by Mr. Maitland, and the third was presented by him to the Mining and Geological Museum, Sydney.

PRODUCTUS TENUISTRIATUS, *De Verneuil.* (?)

VAR. FOORDI, *var. nov.*

(Plate I., figs. 3 and 4; Plate III., fig. 22).

Productus tenuistratus (De Vern.), Foord, Geol. Mag., 1890, vii. (3), p. 151, t. 7, f. 4, 4*a*.

Obs.—A small *Productus* from the Irwin River was referred by Mr. Foord to the above species, a Russian Carboniferous form. I have before me what I believe to be the same shell, represented by numerous specimens from Fossil Hill. I have grave doubts of the wisdom of this determination, of course presuming Mr. Foord's shells and mine to be specificially identical, for the very characters on which the latter relies to unite the West Australian and Russian forms seem to me to separate them.

A glance at De Verneuil's figure[‡] will indicate how remarkably fine, almost microscopically so, are the costal striæ when compared with the much coarser sculpture represented by Mr. Foord's figures. In support of his determination, the latter quotes a figure of Mr. T. Tschernyschew's[§] representing De Verneuil's species. If the recent Russian Palæontologist's determination is correct, then his figures bridge over the interval between De Verneuil and Foord's illustrations. Even the former are more in accord with Foord's than with De Verneuil's, and differ from the last-named precisely as Foord's do. Were it not that the costation in *P. Neffidievi*, De Vern,[*] another Russian species, is more regular, I would be inclined to regard it as a nearer ally of the West Australian form than *P. tenuistriatus*.

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[*] Mon. Genres *Productus et Chonetes*, 1847, t. 9, f. 1 *d* and *e*.

[†] Palaeontographica, 1892, xxxix., Lief. 1, t. 2, f. 4–10.

[‡] Murchison's Geol. Russia in Europe, 1845, ii., p. 260, t. 16, f. 6.

[§] Mém. Com. Géol. Russie, 1899, iii., No. 4, p. 372, t. 6. f. 15 a-c.

The *Producti* from Fossil Hill are of the *P. cora* type in outline, with an inflated visceral region high above the cardinal margin, but without overhanging the latter, and small alar expansions, with occasional transverse plications. The costæ of the ventral valve vary very much; they are threadlike without being absolutely fine, direct or flexuous, occasionally irregular, entire or bifurcate, the forking taking place at about half the length of the shell, and separated by intercostal spaces as wide as the costæ are thick, or wider; the interpolated costæ soon acquire the same thickness as the parent ones. There are no spine bases or tubercles on the body of the ventral valve, but at times a few may be seen immediately below the cardinal margin. I do not think any of my specimens exhibit the true outer shell layer; they all appear to be more or less exfoliated, and, from the appearance of the figure, I imagine Mr. Foord's specimen was also. The ventral valve is evenly rounded, without the slightest sign of a sinus.

If the spine bases, scattered over the surface of *P. lineatus*, Waagen[†], be omitted from consideration, the West Australian *Productus* bears a suspiciously close resemblance to it, more particularly the small variety figured under this name by Diener.[‡]

A number of other described species might be compared, did space permit. Amongst these may be mentioned *P. hemispherium*, Kutorga, figured by Mr. G. von Arthaber [§], possessing a similarly fine sculpture. This is again seen in *P. lævicostus*, White, [||] but the outline is too triangular for the present shell.

In view of the doubt expressed in the opening paragraph of the identity of the shell with De Verneuil's Russian species, I propose to distinguish it in the meantime by the varietal name, *Foordi*.

Loc.—Fossil Hill, Wyndham River.

GENUS STROPHALOSIA, *King*, 1844.

(Ann. Mag. Nat. Hist., 1844, xiv., p. 313.)

STROPHALOSIA, *sp. ind.*

(Plate I., figs. 10-12.)

(*?*) *Strophalosia Clarkei*, Foord, Geol. Mag., 1890, vii. (3), p. 103, t. 5, f. 7, 7a, 8.

Obs.—A small *Strophalosia*, uniform in size throughout the suite of specimens, but unfortunately they are all more or less embedded in matrix. They are, I believe, identical with those referred by Mr. Foord to *S. Clarkei*, Etheridge. None of the specimens exhibit the external shelly layer, but, as Mr. Foord says of his fossils, have a "silky appearance," and are pitted, not punctate, I think. In the absence of satisfactory material, I hardly feel justified in attaching a specific name, and at the same time feel indisposed to regard either these gathered by Mr. Maitland, or those from the Fitzroy River described by Mr. Foord, as *S. Clarkei*, and for the following reasons:—

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[*] Murchison's Geol. Russia in Europe, 1845, ii., p. 259, t. 18, f. 2. [†] Salt Range Foss. (Pal. Ind.), 1884, i., Pt. 4, Fas. 4, p. 673, t. 66, f. 1a., 2d. [‡] Himalayan Foss. (Pal. Ind.), 1897, i., Pt. 3, t. 4, f. 2a and 5d. [§] Beitrage Pal. Oster-Ungarns, 1900, xii., Heft.4, p. 256, t. 20, f. 4, *b* and *c*. This must not be confounded with the much older *P. hemisphærium*, Sby. [||] Hall and Whitfield, Rep. U.S. Geol. Explor. 40th Parallel (King's) 1877, iv., Pt. 2. p. 266, t. 5, f. 7 & 8.

(1.) The uniformly small size of the specimens as compared with that of typical examples from Queensland and New South Wales localities;

(2.) The much less convexity of outline in the ventral valve;

(3.) The depressed umbonal region of the ventral valve, hardly rising above the level of the cardinal margin;

(4.) Extreme concavity of the dorsal valve;

(5.) Shorter septum in the dorsal valve;

(6.) Comparatively wider reniform impressions in the same valve.

On the other hand, the cardinal margin is long as in *S. Clarkei*, thus opposed to this character in the other Australian species, *S. Gerardi*, King, and *S. Jukesii*, mihi, from both of which the Western Australian form also differs in the absence of spines. Had these existed some trace would have been left, notwithstanding the loss of the outer shelly layer. The impression conveyed to my mind by Mr. Foord's figures, and the specimens before me is that of a fourth Australian species not previously recognised. The following characters can be gleaned from the specimens:—The outline was transversely sub-oval; the lateral and ventral margins regularly rounded; the ventral valve gently and regularly convex without being vaulted, and without sinus, a straight cardinal margin barely as wide as the valve, with a well marked area for its size, but above which the umbonal region barely rises. There are small but well-defined alar expansions, particularly internally; there is a narrow linear deltidium, and the teeth, although small, are prominent and projecting. The dorsal valve concave exteriorly, but internally flat, with strongly bevelled margins; the area somewhat narrow, and pyriform diverging dental sockets.

There is no trace of spines either on the surface of the ventral valve, nor along the cardinal margin.

Loc.—Coolkilya Pool, Wandagee Station, Minilya River.

GENUS AULOSTEGES, *Helmersen*, 1847.

(Bull., Acad. Sci. St. Petersb., 1847, vi., p. 135.)

AULOSTEGES BARACOODENSIS, *sp. nov.*

(Plate II., figs. 1-2a.)

Sp. Char.—Shell large, rotundo-quadrate, longer than wide, concavo-convex, the convexity of low degree; cardinal margins much shorter than the greatest width of the shell; auricles not highly developed, coincident with the curvature of the valves; cardinal angles obtusely rounded, neither quadrangular nor emarginate; lateral and ventral margins rounded, the latter faintly insinuated centrally. Ventral or pedicle valve more or less convex, but not inflated, and with a faint sinus; umbonal region high, the umbo blunt and barely overturned; area high, approximately from half to one-third the width of the cardinal margin, transversely lined but not distorted; delthyrium high and linear; deltidium very narrow, annulate but not spined or twisted. Brachial or dorsal valve concave; cardinal area linear; cardinal process small and spike-like externally; septum rather strong and showing through the test, extending for two-thirds the length of the valve. Sculpture in both valves of concentric latilaminæ, thickly set with scattered tubular spines, arising from irregularly developed low costæ; spines when broken or worn leaving perforated tubercles.

Obs.—This remarkably fine species I believe to be an *Aulosteges* rather than a *Strophalosia*. Cardinal teeth have not been observed, nor is there any trace of umbonal attachment; moreover, the deltidium partakes much more of that of the former than the latter genus, and does not quite extend to the actual cardinal margin. Again, the linear cardinal area of the brachial valve is not exposed exteriorly as in *Strophalosia*.

I have seen two specimens, one collected by Mr. Maitland, forming a part of the present series, and another presented by Mr. J. Connelly, Junr., to the Mining and Geological Museum. The length of these shells varies from two and three-quarter inches to three and a-quarter inches, and the breadth is the same.

A. baracoodensis exceeds the type of the genus, *A. Wangenheimi*, De Vern.[*] many times in size and possesses an area that does not extend the whole length of the cardinal margin. It is, however, to two of the Indian Salt Range species that *A. baracoodensis* approaches nearest, viz.:—*A. medlicottianus* Waagen[†] and *A. Dalhousi*, Davidson,[‡] but again it exceeds both in size. As regards the first of these two species, the less elevated area and form of sculpture also separates it from *A. baracoodensis*. The second Indian species possesses a similar high pedicle area, elevated umbonal region, and straight delthirium to the like parts in the West Australian form, but the area extends the whole length of the cardinal margin, and the alar expansions are different. There is a third Indian species, *A. tibeticus* Diener[*] resembling *A. Dalhousi*, but very much larger. On the whole, *A. baracoodensis* is more nearly allied to Davidson's shell than to any other.

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[*] *Orthis*, Murchison's Geol. Russia in Europe, 1845, ii, p. 194, t. 11, f. 5a and b; *Aulosteges*, Davidson, Brit. Foss. Brach. 1853, i. (Introd.), p. 116, t. 9, f. 212-215; *id.*, Geinitz, Dyas, 1861, p. 95, t. 17, f. 20, *a-f*. [†] Salt Range Fossils (Pal. Ind.), 1884, i., Pt. 4, p. 663, t. 62. [‡] Quart. Journ. Geol. Soc., 1862, xviii., p. 33, t. 2, f. 7*a* and *b*; Waagen, Salt Range Foss. (Pal. Ind.), 1884, i., Pt. 4, p. 662, t. 63, f. 1 *a-c*.

Loc.—Baracooda Pool, Arthur River. The specimen in the Mining and Geological Museum, Sydney, is from the Wooramel River (*Pres. J. Connelly, Junr.*).

GENUS CHONETES, *Fischer*, 1837.

(Oryctographie Gouv. Moscou, 1837, p. 134.)

CHONETES PRATTI, *Davidson*.

Chonetes Pratti, Davidson, Geologist, 1859, p. 116, t. 4, f. 9-12.

Chonetes Pratti, Bullen Newton, Geol. Mag. 1892, ix. (3), p. 542, t. 14.

Obs.—Numerous specimens in various stages of preservation are displayed on two hand-specimens of highly fossiliferous shale, and illustrate most of the characters described by Messrs. Davidson and Newton.

From the second and third localities recorded below are a few other less well preserved examples of a *Chonetes*, with the outward appearance of *C. Pratti*; in all probability they are this species also.

Loc.—Fossil Hill, Wyndham River; (?) Wandagee Station; and Wandagee Hill, Minilya River.

PELECYPODA.

GENUS AVICULOPECTEN, *McCoy*, 1851.

(Ann. Mag. Nat. Hist., 1851, vii. (2), p. 171.)

AVICULOPECTEN TENUICOLLIS, *Dana, sp.*

(Plate III., figs. 3 and 4.)

Pecten tenuicollis, Dana, Am. Journ. Sci., 1847, iv. (2), p. 160.

Pecten tenuicollis, Dana, Wilkes U.S. Explor. Exped., 1849, x. Geol., p. 705, t. 9, f. 7.

Aviculopecten tenuicollis, Eth. fil., Cat. Austr. Foss., 1878, p. 67.

Aviculopecten tenuicollis, Eth. fil., Proc. Linn. Soc. N.S. Wales, 1889, iv. (2), p. 203.

Aviculopecten tenuicollis, Foord, Geol. Mag., 1890, vii. (3), p. 103, t. 5, f. 9.

Sp. Char.—Shell of medium size, suborbicular, nearly equilateral, length and breadth about equal. Right (?) valve gently convex, spreading towards the front, contracted towards the umbo;

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[*] Himalaya Foss. (Pal. Ind.), 1897, i. Pt. 3, p. 35 and 5, f. 3-6.

the ventral margin semicircular, cardinal margin straight, less than the width of the valve; umbo acute; anterior and posterior slopes abrupt and steep. Auricles apparently nearly equal, flat, triangular, one bears three radiating costæ, the other appears plain. Costæ numerous, 20-26 (?), radially curved, entire, rounded, coarse, separated by flat intercostal spaces each bearing a secondary interpolated rib, but not reaching to the umbo, the whole crossed by very fine, close, flat, frill-like laminæ, rendering the primary costæ (at any rate) slightly spinose towards the front of the valve.

Obs.—There are three mutilated specimens from one locality, and a fairly well preserved valve from a second place that enable me to give a slightly emended description to that drawn up from previously examined Kimberley material. Confirmation is also afforded of my previous description of fine concentric frill sculpture, which is well shown on one of the mutilated specimens.

Loc.—Boulder bed, Wyndham River, Lyons District (valve); Wandagee Station, Minilya River.

GASTEROPODA.

GENUS PTYCHOMPHALINA (*Bayle*), *Fischer*, 1885.

(Man. Conchyl. et Pal. Conchyl., Fas. 9, 1885, p. 850.)

PTYCHOMPHALINA MAITLANDI, *sp. nov.*

(Plate I., figs. 13-15.)

Sp. Char.—Shell of moderate size, conical, short, stout, of four of five whorls: body whorl obtusely angular, convex below, flat and obliquely inclined, or a little concave above: posterior whorls rounded, tightly embracing, sutures simple and close. Band well marked, placed on the angle of the body whorl, but immediately super-sutural on the others, and defined by two fine keels, with the intermediate band surface slightly concave. Mouth oval and rather oblique: inner lip slightly reflected, and separated from the base of the body-whorl by a fine, simple groove. Sculpture consisting of very fine regular oblique direct lines on the posterior whorls, forming retral curves to and from the band on the body-whorl with a slight tendency to become sigmoidal on the base: neither spiral lines nor granules.

Obs.—A short stout shell, the outline more nearly approaching that of a *Gosseletina* rather than that of *Ptychomphalina*.

In defining *Ptychomphalina*, De Koninck (as *Ptychomphalus*, De Kon., *non* L. Ag.) simply states that the band is visible on all the whorls, without assigning to it any particular position, but I find from his figures that it is almost, if not always, sutural on the posterior whorls, and more or less median on the body-whorl.

In some respects *P. Maitlandi* is not unlike the poorly preserved "*Pleurotomaria ? ?*" figured by Foord* from the King Leopold Ranges, but I hardly think the two are identical.

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* Geol. Mag., 1890, vii. (3), p. 104, t. 4, f. 10, 10a.

The angularity of the body-whorl distinguishes it from a badly preserved Pleurotomarid I figured[*] from Treachery Bay, Port Darwin, and provisionally referred to *Mourlonia humilis*, De Kon., sp.

Loc.—Wandagee Station, Minilya River.

III.—An Endophytic Fungus Infesting Enlarged Crinoid Stems.

In 1879 I published a paper, "Observations on the Swollen Condition of Carboniferous Crinoid Stems,"[†] in which I referred to the already known information on the subject, including the remarks of David Ure, Schlotheim, Miller, the Messrs. Austin, Rofe, and others, and described a series of enlarged stems from the Carboniferous Systems of England and Scotland. I showed that the enlargement or distortion was caused—

(1.) By an effort on the part of the Crinoid to repair damages caused by the loss of a cirrus;

(2.) By the abnormal secretion of stereom over extraneous attached foreign bodies, such as corals, stems of smaller Crinoids, encrusting Polyzoa and adherent Brachiopoda;

(3.) By the attack of supposed boring parasites.

In 1884 my late friend, Dr. P. H. Carpenter,[‡] stated that abnormal growths of the calcareous tissue of the arms of some of the Comatulæ and Pentacrinidæ, dredged by the Challenger Expedition, were due to one of the Bristle Worms (*Myzostoma*), but similar enlargements were not found on the stems. At the same time he expressed the opinion, held in common with Professor J. Von Graff, that certain swollen stems of *Millericrinus*, figured by De Loriol from the Jurassic rocks of France and Switzerland were due to cystiferous enlargements caused by *Myzostoma*. Later Dr. Von Graff published[§] an interesting account of the ravages of *Myzostoma* proper in recent and fossil Crinoids. He considered that, amongst other things, many of the swollen stems met with in the fossil state are due to this worm.

Mr. F. A. Bather, contributed a few remarks on this subject in his "Crinoidea of Gothland." Of the stem of *Botryocrinus ramosissimus*, Ang., he remarked:—"The stem is always slightly swollen above the cirri. This swelling was perhaps induced by the attacks of boring parasites, of which there are traces: the middle of the stem also shows numerous small pittings, irregular in disposition, which are probably the work of parasites."[*] Again, in the distal part of the stem of *Gissocrinus incurvatus* Ang. sp. "there is considerable irregularity, and the ossicles are broken up by longitudinal or oblique sutures. Whether this is a pathological or senile development, or whether it is an original structure, is uncertain."[†] This irregularity is well exhibited in some of the present specimens.

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[*] Contrib. Pal. S. Austr., S.*A. Parl. Papers*, 1897, No. 127, p. 15, t. 1, f. 11.

Proc. Nat. Hist. Soc. Glasgow, 1879, iv., p. 19.

[‡] Challenger Report, Zool., xi., p. 134.

[§] Palaeontographica, 1885, xxxi., p. 185.

Another remarkable instance of this cyst-like growth is figured by Messrs. Wachsmuth and Springer on two cirri apparently of *Batocrinus grandis*. They say[‡]—"Similar cysts are frequently found along the stem, but have not before been found to occur on the cirri. They resemble the Myzostoma cysts which occur along the arms of recent Comatulæ, and like them were evidently caused by parasites." Similar cysts are shown on two arms of an example of *Agaricocrinus inflatus* Hall,[§] and parasitic growths on an unnamed radial plate and on the base of a *Platycrinus*,[||] etc., all these might perhaps give rise to such irritation as to cause increased deposition of stereom, and ultimately become enlargements. P. de Loriol figures other excellent examples of cystoid expansions amongst Secondary Crinoidea. Swellings are shown on the stems of *Millericrinus granulosus*, Etallon,[¶] from the Kelloway and Oxfordian beds of the Oolite, and *Millericrinus*, sp.[**] from the Corallian; these are some of the most striking enlargements I have seen.

The foregoing references are introduced with the view of indicating some of the principal causes of cystoid swellings amongst the Crinoidea. I now purpose describing some stem enlargements infected with an organism of a totally different nature, an endophytic fungoid growth. Plate IV., figs. 1–6, illustrate the outward form of the stems previous to cutting for the preparation of microscopic sections, and on the same plate, Figs. 7–9, are given some of the more characteristic appearances of the intruding body, slightly magnified, very carefully executed by my colleague, Mr. Edgar R. Waite.

Plate IV., fig. 1, illustrates portion of a column with an open cicatrix, somewhat quadrangular in outline, the stem wall impressed around the edges of the opening, and the columnals deformed; enlargement has taken place more on one side than the other. The cicatrix closely resembles one previously figured[††] by me from the British Carboniferous, the cause of secretion of stereom being apparently an *Archæopora*; on slicing this stem it became evident that penetration had extended inwards but a very short distance.

A microscopic section reveals the fact that the shallow excavation and the crevices leading from it are filled with an olive, or sherry-yellow, flocculent-looking material, with here and there irregularly shaped brown to black pigment masses, and scattered round black bodies. The flocculent matter also more or less permeates the surrounding stereom, and is continued along the joints between the columnals, even to the axial canal. There are also a series of similarly affected parallel longitudinal zones extending through the columnals. The black pigment masses are either homogenously so, or when at all broken up or with frayed edges, are seen to be composed of groups of spherical bodies exactly resembling the spores of *Palæoperone endophytica*, mihi, or the heterospores of *Palæopede Whiteleggei*, mihi. The scattered, round black bodies are of a similar nature, and are either single, or united in twos or threes by a stolon; they are not confined to the floculent matter but are to be found in the substance of the stereom itself.

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[*] *Loc cit.* 1893, Pt. 1, p. 120. t. 6, f. 174-176.

[†] *Ibid.* p. 170, t. 10, f. 347.

[‡] N. American Crinoidea Camerata, 1897, i., p. 43, t. 1, f. 2.

[§] Wachsmuth and Springer, *Loc. cit.*, p. 502, p. 39, f. 7.

[||] Wachsmuth and Springer, *Loc. cit.* t. 4, f. 18-20.

[¶] Pal. Franç. Terr. Juras., Crinoides, 1883, Pt. 1, Feuil. 16–18, t. 63, f. 2, 4, 5, 6, 7, 8, 8a, 9, 22, etc.

[**] *Ibid*, 1884, Pt. 1, Feuil. 25–27, t. 99, f. 2, 2a, 4, 4a.

[††] Proc. Nat. Hist. Soc. Glasgow, 1879, iv., t. 1, f. 16 and 17.

In Plate IV., fig. 2, the column is slightly enlarged, with a, to all intents and purposes, closed cicatrix, and the columnals again deflected from their normal position. On slicing, however, the fact is revealed that the original opening led into a chamber between the outer wall and the axial canal, subsequently closed by a deposition of stereom. One of my previous figures[*] resembles this, except that the closed cavity communicates with the axial canal.

We find by means of a microscopic section that the T-shaped (in section) cavity is filled with fragments of clear calcite, and the cracks between these lined with the flocculent deposit, the pigment masses, and scattered spores. The stereom immediately above and below the chamber is densely packed with the pigment masses and scattered spores, the former assuming a more or less arborescent appearance. The whole of the axial canal comprised within the section is attacked, particularly with scattered spores.

Plate IV., fig. 3, represents an irregularly enlarged stem which seems to have been attacked in two places. Above is a small cicatrix evinced by a depression, and the usual disorganisation of the columnals. Below is the second swelling, without any trace of a cicatrix at all, but exhibiting two columnals greatly increased in width at the expense of the others, whose growth appears to have been entirely stayed. On slicing this specimen the other cicatrix was found to lead into a very shallow, as it may be termed, subcutaneous cavity having much the appearance of a true *Myzostoma* tube. Within the lower enlargement is a more or less quadrangular cavity surrounding the axial canal.

The microscopic section shows that this latter cavity is filled with clear calcite, flocculent matter, and clusters of black and yellow spores.

Plate IV., fig. 4, is a bilateral symmetrically enlarged stem with several cicatrices, more or less closed, and with much disturbance of the columnals. In this instance nearly the whole of the interior of the stem is affected, both along the axial canal and the stereom intervening between the latter and the new enclosing layer forming the exterior. One well marked opening is presented with the edges rounded inwards, not caused by attrition, but by a regular semi-circular deposition of new stereom by the Crinoid in its endeavour to close the aperture. The lower lip of the aperture is fractured inwards, and leads into a large irregular-shaped space occupying nearly the whole interior of the column-portion, from a thin exterior shell of stereom back to and inclusive of the axial canal. The whole of this space is intensely affected with dense black patches of pigment matter, breaking up into connected tube-like branches, and finally into scattered separate spores. Wherever traversed by the intruding body the stereom in this column is much altered.

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[*] Proc. Nat. Hist. Soc. Glasgow, 1879, IV., t. 1, f. 8.

An unsymmetrically enlarged, more or less barrel-shaped stem portion is represented in Plate IV., fig. 5. There was evidently great disorganisation of the columnals, as in fig. 2, but the cicatrix is externally hidden by an encrusting growth of Polyzoa. On slicing no tube was cut, but an internal digitate cavity revealed under the convexity presented by the front of the figure, and near the axial canal. In the superimposed hump of stereom the columnal sutures are obliterated in the section. A general idea of this cavity, except that it is not double, may be gained from one of Von Graaf's figures,* which he ascribes to *Myzostoma*. The infilling of this cavity is of a white colour, and does not microscopically present any features of interest.

Plate IV., fig. 6, is a barrel-shaped enlargement, with only the faintest trace of a cicatrix; but there is a similar broadening out of some of the columnals at the expense of others, as seen in figs. 3, 4, and 5. On slicing, a large triangular cavity becomes evident, extending back to and connected with the axial canal. It is filled with a dark ochreous-brown deposit. The whole axial canal is affected and filled with a similar material. A microscopic section reveals the fact that this ochreous in-filling, both in the cavity and axial canal, consists of highly discoloured secondary stereom, containing broken-up patches of the olive-yellow floculent material, a few masses of the dark pigment matter, and a large number of scattered spores of a lighter colour than usual.

That the intruding body set up considerable irritation in the tissues of these Crinoid stems, I think there can be very little doubt; but whether or no it was the primary cause is open to question. No distinct evidence exists of the nature of the original intruder; possibly it was similar to one or other of the agents described elsewhere. It is hardly feasible that the fungoid growth prepared the openings; more likely that its spores penetrated the already open passages, and propagated there, so completing what the original intruder had commenced.

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* Palaeontographica, 1885, xxxi., t. 16, f. 4.

Taking the whole of the sections together, the endophytic growth occurs in one or other of the following conditions:—

(1.) Olive-brown to sherry-yellow flocculent matter, very plentiful, and penetrating the stereom in all directions, and may result from the ultimate disintegration of No. 2.

(2.) Amorphus masses of pigment matter varying in colour from deep amber brown to dense black, frequently dissolving wholly or more particularly around the edges into Nos. 4, 5, and 8.

(3.) Sub-dendritic masses of this pigment matter, with indistinct traces of No. 5.

(4.) Small bone-lacunæ-like masses of No. 2, usually of a much lighter colour.

(5.) Irregularly-shaped clusters of distinctly formed globular bodies (? oospores) varying in colour from sherry-yellow to dense black, often resembling a series of tubers united by stolons or stoloniferous roots, dissolving into No. 6.

(6.) The globular bodies (? oospores) in moniliform sequence, but without any trace of stoloniferous union.

(7.) The same bodies often lying contiguous to one another in pairs.

(8.) The same bodies scattered singly in the stereom and varying very much in size.

The structures above described are in many ways suggestive of Thallophytes allied to those described by the late Professor P. M. Duncan as *Palæachlya perforans*,[*] and *Achlyites penetrans*,[†] and the following by myself—*Palæachlya tortuosa*,[‡] *P. torquis*,[§] *Palæoperone endophytica*,[||] and *Palæopede*[¶] *Whiteleggei*. The olive, sherry-yellow, or amber flocculent matter, black pigment masses and globular bodies, etc., have been seen in all, but in no instance in the Crinoid stem-portions have I detected tortuous tubes like those of *Achlya perforans*, *P. tortuosa*, or *P. torquis*, pin-like tubes similar to those of *Palæoperone endophytica*, nor stoloniferous chains of moniliform cells and heterospores as in the alga *Palæopede Whiteleggei*. The flocculent matter, which accompanies most of these organisms distributed through the surrounding tissues of the host is seen in the visceral chambers of the *Favosites* containing *Palæachlya torquis*, just as it does the stereom of the Crinoid stems, and in the visceral chambers of *Stenopora crinita* containing the pin-tubes of *Palæoperone endophytica*.

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[*] Quart. Journ. Geol. Soc., 1876, xxxii, p. 210. [†] Achlya, Proc. R. Soc. 1876, xxv., No. 174, p. 252. [‡] Rec. Geol. Survey N.S. Wales, 1891. ii., No. 3, p. 96. [§] Rec. Austr. Mus., 1899, iii., No. 5, p. 126. [||] Rec. Geol. Survey N. S. Wales, 1891, iii., No. 3, p. 9. [¶] Rec. Austr. Mus., 1899, iii., No. 5, p. 127.

In the Crinoid stem-portions the dark pigment masses are of irregular outline, but also line any chance cavity, just as Duncan describes similar lines in the tubes of *Palæachlya perforans*,* often, however, assuming a bone-lacunœ-like to sub-dendritic appearance. In the former state the pigment masses are precisely similar to those observed by Duncan in a Tasmanian *Thamnastræa*. He speaks of the tubes "frequently merged into an irregular dark mass and resembled the tubuli of bone (Haversian canals) passing into lacunæ." † In some of my sections again, these lacunæ-like patches are of a peculiar pale vermilion tint, not unlike the infilling of some of the *Palæachlya* tubes in *Calceola*, of a "reddish tint," also noticed by Duncan. ‡

In the absence of any tubular structure I think it will be more satisfactory to refer this form to the Genus *Achlyites*, as used by Dr. A. Meschinelli. §

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IV.—Palæoperone Infesting the Visceral Chambers of Hexagonella.

The visceral chambers of both corals *Hexagonella dendroidea* and *H.* (?) *crucialis* are infested with a fungoid growth, in some of its characters quite in keeping with that already described in the Crinoid stem-portions. In addition, however, are clusters of minute tubes, reminding one of those of *Palæoperone endophytica*. Both the autopores and mesopores are occupied by this growth, but the former most so, and it is more copious in *H. dendroidea* than *H.* (?) *crucialis*. The various phases assumed are as follows:—

(1.) A copious development of the olive to sherry-yellow flocculent matter containing minute brown grains, and here and there faint, although decided, bifurcating filaments running through it (? mycelium). In the autopores, cracks in the infilling calcite are also penetrated by this substance.

(2.) Tubes parallel or sub-radiate, having a diameter of about ·04 mm., either transverse to or parallel to the growth of the autopore visceral chambers (Plate V., fig. 1). These are either filled or partially filled with the flocculent matter in various stages of density, from translucent to opaque, and even passing into the black pigment condition, or they may be empty, but surrounded by the flocculent matter (Plate V., fig. 1). I have not observed an instance of the enlargement of one of the tubes into a loculus at one end.

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(4.) Detached globular spores (? oospores), varying in size, with an average diameter of ·02 mm., black, brown, or even red, either singly (Plate V., fig. 3), in clusters (Plate V., figs. 4, 5), united in pairs (Plate V., fig. 3), or forming sub-dendroid masses (plate V., fig. 8), or apparently arranged in linear series (Plate V., figs. 6, 7).

(5.) In one particular section three of these spores are to be seen attached to the ends of the tubes more or less after the manner of *Palæoperone endophytica* (Plate V., fig. 2).

It may be noted that the tubes in question do not penetrate the tissues of these corals like those of some species of *Palæachlya*, but are simply resting tubes similar to those of *Palæoperone*. For this reason the endophyte of *Hexagonella* is referred provisionally to that genus.

In conclusion I would like to point out that in some of Waagen and Wentzel's figures of *Hexagonella*, from the Salt Range, the corrallites contain black spots and patches, closely resembling the appearance of the endophytic form under description. These may be only patches of matrix, on the other hand, they may be of the nature of *Palæoperone*. I make this suggestion for what it may be worth; it is, however, significant, as I have elsewhere pointed out, that the corrallite tissues of another Salt Range species *Geinitzella columnaris*, Schl., sp.,[*] do unquestionably exhibit penetrating tubes similar to those of *Palæachlya penetrans*, and *P. torquis*. The *Hexagonella* referred to is *H. ramosa*, W. & W. [†]

I am indebted to my colleague, Mr. T. Whitelegge for the various measurements of these minute organisms.

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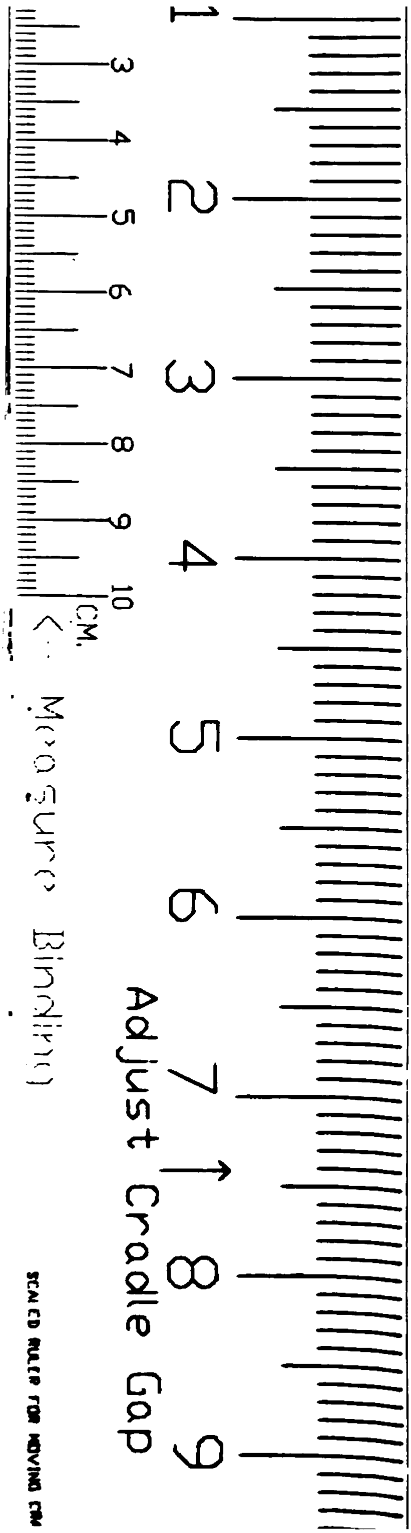

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(4.) Detached globular spores (? oospores), varying in size, with an average diameter of ·02 mm., black, brown, or even red, either singly (Plate V., fig. 3), in clusters (Plate V., figs. 4, 5), united in pairs (Plate V., fig. 3), or forming sub-dendroid masses (plate V., fig. 8), or apparently arranged in linear series (Plate V., figs. 6, 7).

(5.) In one particular section three of these spores are to be seen attached to the ends of the tubes more or less after the manner of *Palæoperone endophytica* (Plate V., fig. 2).

It may be noted that the tubes in question do not penetrate the tissues of these corals like those of some species of *Palæachlya*, but are simply resting tubes similar to those of *Palæoperone*. For this reason the endophyte of *Hexagonella* is referred provisionally to that genus.

In conclusion I would like to point out that in some of Waagen and Wentzel's figures of *Hexagonella*, from the Salt Range, the corrallites contain black spots and patches, closely resembling the appearance of the endophytic form under description. These may be only patches of matrix, on the other hand, they may be of the nature of *Palæoperone*. I make this suggestion for what it may be worth; it is, however, significant, as I have elsewhere pointed out, that the corrallite tissues of another Salt Range species *Geinitzella columnaris*, Schl., sp.,* do unquestionably exhibit penetrating tubes similar to those of *Palæachlya penetrans*, and *P. torquis*. The *Hexagonella* referred to is *H. ramosa*, W. & W. †

I am indebted to my colleague, Mr. T. Whitelegge for the various measurements of these minute organisms.

---

* Salt Range Foss. (Pal. Ind.) 1886, i. Pt. 6, t. 115, f. 1.

† *Ibid*, t. 106, f. 3 and 4.

In the Crinoid stem-portions the dark pigment masses are of irregular outline, but also line any chance cavity, just as Duncan describes similar lines in the tubes of *Palæachlya perforans*,[*] often, however, assuming a bone-lacunœ-like to sub-dendritic appearance. In the former state the pigment masses are precisely similar to those observed by Duncan in a Tasmanian *Thamnastræa*. He speaks of the tubes "frequently merged into an irregular dark mass and resembled the tubuli of bone (Haversian canals) passing into lacunæ."[†] In some of my sections again, these lacunæ-like patches are of a peculiar pale vermilion tint, not unlike the infilling of some of the *Palæachlya* tubes in *Calceola*, of a "reddish tint," also noticed by Duncan.[‡]

In the absence of any tubular structure I think it will be more satisfactory to refer this form to the Genus *Achlyites*, as used by Dr. A. Meschinelli.[§]

The Crinoid stems were collected by Mr. Maitland at Williambury Station, Minilya River.

IV.—Palæoperone Infesting the Visceral Chambers of Hexagonella.

The visceral chambers of both corals *Hexagonella dendroidea* and *H.* (?) *crucialis* are infested with a fungoid growth, in some of its characters quite in keeping with that already described in the Crinoid stem-portions. In addition, however, are clusters of minute tubes, reminding one of those of *Palæoperone endophytica*. Both the autopores and mesopores are occupied by this growth, but the former most so, and it is more copious in *H. dendroidea* than *H.* (?) *crucialis*. The various phases assumed are as follows:—

(1.) A copious development of the olive to sherry-yellow flocculent matter containing minute brown grains, and here and there faint, although decided, bifurcating filaments running through it (? mycelium). In the autopores, cracks in the infilling calcite are also penetrated by this substance.

(2.) Tubes parallel or sub-radiate, having a diameter of about ·04 mm., either transverse to or parallel to the growth of the autopore visceral chambers (Plate V., fig. 1). These are either filled or partially filled with the flocculent matter in various stages of density, from translucent to opaque, and even passing into the black pigment condition, or they may be empty, but surrounded by the flocculent matter (Plate V., fig. 1). I have not observed an instance of the enlargement of one of the tubes into a loculus at one end.

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[*] Quart. Journ. Geol. Soc., 1876, xxxii., p. 208.

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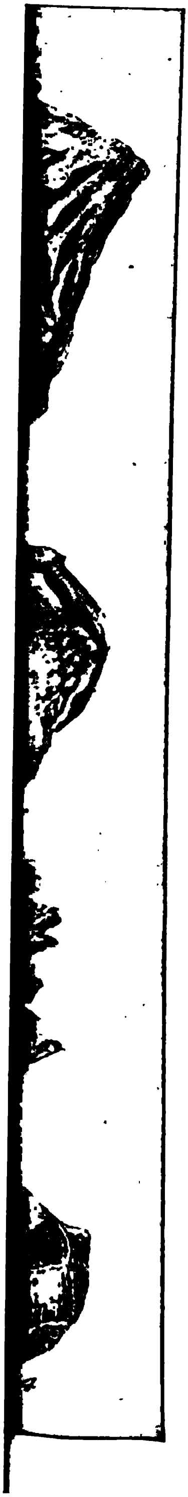


PLATE I.

CHONDRITES, *sp.*

Fig. 1.—Portion of shale with impressions of a *Chondrites*-like plant.

CRUSTACEAN (?) TRACK.

„ 2.—Moniliform or beaded track in sandy shale, possibly that of a Crustacean.

PRODUCTUS TENUISTRIATUS, *De Vern* (?), *var.* FOORDI, *Eth. fil.*

„ 3.—Ventral valve with costæ.

„ 4.—Ventral valve more or less decorticated with small alar expansions.

SEMINULA, *sp. ind.*

„ 5.—Ventral valve with laminæ of growth.

SPIRIFERA HARDMANI, *Foord.*

„ 6.—Ventral valve showing area, etc.

„ 7.—Another and stouter specimen. The smaller valve I am inclined to refer to *S. musakhleyensis*, Dav.

SPIRIFERA LATA, *McCoy* (?).

„ 8.—A ventral valve, probably a variety of this species.

SPIRIFERA, *sp. ind.*

„ 9.—Dorsal valve of an alate Spirifer.

STROPHALOSIA, *sp. ind.*

„ 10.—A ventral valve exfoliated, possessing a silky appearance.

„ 11.—Interior of a ventral valve, exhibiting the area, narrow deltidium and teeth.

„ 12.—Interior of a dorsal valve, displaying the dental sockets.

PTYCHOMPHALINA MAITLANDI, *Eth. fil.*

„ 13.—View of a medium-sized specimen, exhibiting five whorls sculpture, and band.

„ 14.—A larger but imperfect individual displaying the mouth.

„ 15.—A portion of the band of Fig. 13, enlarged.

PLATE II.

AULOSTEGES BARACOODENSIS, *Eth. fil.*

Fig. 1.—Ventral valve, showing the concentric latilaminæ and scattered broken spine bases.

„ 2.—The dorsal valve and ventral area with its narrow annulate deltidium.

„ 2a.—The deltidium enlarged.

PRODUCTUS SEMIRETICULATUS, *Martin, sp.*

„ 3.—Portion of a worn ventral valve.

„ 4.—Dorsal view of the same specimen. (Fig. 3.)

„ 5.—Side view of the same. (Fig. 3.)

SPIRIFERA, *sp. ind.*

„ 6.—Interior of the dorsal valve, Pl. 1, Fig. 9.

SPIRIFERA HARDMANI, *Foord.*

„ 7.—Ventral valve; exterior view of Pl. 1, Fig. 6.

„ 8.—Ventral valve; exterior view of Pl. 1, Fig. 7.

„ 9.—Ventral valve, exhibiting the V-shaped latilaminæ.

PLATE III.

Hexagonella (?) crucialis, *Hudleston, sp.*

Fig. 1.—Portion of a four-rayed somewhat weathered corallum.

Spirorbis ambiguus, *Fleming*

„ 2.—A tube adhering to a valve of *Cleiothyris macleayana*.

Aviculopecten tenuicollis, *Dana.*

„ 3.—A more or less complete valve, displaying the radiating costæ, and transverse imbricating laminæ.

„ 4.—Portion of a smaller valve showing the interpolated ribs and imbricating laminæ.

Cleiothyris macleayana, *var.* baracoodensis, *Eth. fil.*

„ 5.—View of the dorsal valve, showing outline

„ 6.—Ventral valve and portion of another.

„ 7.—Dorsal valve with remains of sculpture.

„ 8.—The united valves, the nearly flat ventral above.

„ 9.—The same specimen (Figs. 5 and 8) seen from the side.

Cleiothyris macleayana *Eth. fil.*

„ 10.—A slightly concave ventral valve.

„ 11.—Dorsal valve with a portion of the test worn away, showing a part of one of the spiral cones.

„ 12.—An almost flat ventral valve.

„ 13.—Ventral valve with the concentric spinose laminæ well shown.

„ 14.—Interior of the same valve (Fig. 13).

„ 15.—Interior of another ventral valve.

„ 15*a*.—Side view of a portion of Fig. 15, displaying the hooked teeth.

„ 16.—The conjoined valves seen from the front, the convex dorsal above.

„ 17.—The conjoined valves (Fig. 16) seen from the cardinal aspect, the flat ventral above.

„ 18.—Conjoined valves of a much flattened individual, the flat ventral above.

„ 19.—Interior of the dorsal valve.

„ 20.—Spine bases protruding from the concentric shell laminæ enlarged.

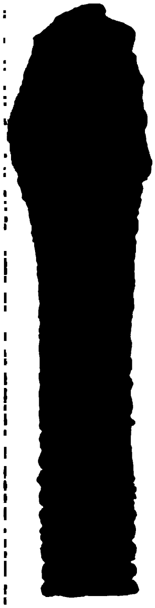
Seminula, *sp. ind.*

„ 21.—Side view of the united valves (Pl. 1, Fig. 5).

Productus tenuistriatus, *De Vern*, var. Foordi, *Eth. fil.*

„ 22.—Ventral valve showing slight alar extremities to the cardinal margin.

6.



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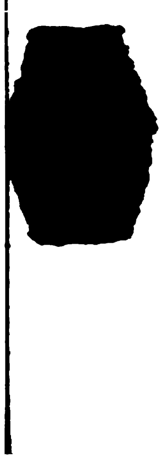

PLATE IV.

ENLARGED CRINOID STEM-PORTIONS.

Fig. 1.—An open cicatrix, somewhat quadrangular in outline, and deformed columnals.

„ 2.—A slightly enlarged stem-portion, a closed cicatrix, and the sutures of the columnals greatly deflected from their normal course.

„ 3.—An irregularly enlarged stem-portion which seems to have been attacked in two places. Above is a slightly marked cicatrix, but below, the enlargement is without an opening of any kind; great disorganisation of the columnals has taken place.

„ 4.—An almost bilaterally symmetrically enlarged portion, with several cicatrices, more or less closed.

„ 5.—Barrel shaped stem-portion, with great columnal disorganisation. The cicatrix is covered by an encrusting Polyzoon.

„ 6.—A somewhat barrel-shaped enlargement, with the faintest trace of a cicatrix.

„ 7.—Section prepared for the microscope from the specimen illustrated in Fig. 6. Both the cavity and axial canal are infested by the Endophyte—x. 3.

„ 8.—A similar section prepared from the subject of Fig. 4. The opening is shown at the right centre and an infection of nearly the whole of the interior of the stem-portion—x. 3.

„ 9.—A third section prepared from the stem-portion represented in Fig. 1. The opening is seen on the right centre and along the sutures between the columnals, and in the axial canal are evidences of the Endophyte's work. This is also shown in certain parallel longitudinal lines passing through the cavity and the columnals—x 3.

3

PLATE V.

PALÆOPERONE ENDOPHYTICA, *Eth. fil.*

Fig. 1.—Transverse section of a cavity (? enlarged autopore) in *Hexagonella dendroidea*, Hudleston, showing both full and empty parallel and sub-parallel tubes—x 60.

" 2.—A number of tubes forming portion of a more or less radiate mass from the transverse section of an autopore of *H. dendroidea*, with, at the upper ends of three of the tubes, protruding spores. The tubes are filled with the olive flocculent matter—x 60.

" 3.—Transverse section of a portion of an autopore of *H. dendroidea*, in which four large spores are visible, a pair, and two single ones. These are of a dense black colour, and protruding from the lower of the central pair is a short stolon—x 500.

" 4.—A slightly oblique section of autopores and mesopores of *H. dendroidea*, showing masses of pigment matter in two of the angles of an autopore, and nearly filling a mesopore; in both instances breaking up into spores—x 250 (about).

" 5.—A similar section from the same species, in which the disintegration of the pigment matter has gone a step further—x 250 (about).

" 6.—Pigment matter and spores from a transverse autopore section of *H. dendroidea*, arranged generally in linear series—x 250 (about).

" 7.—Another like section to that given in Fig. 6, but in which the linear arrangement is more marked—x 250 (about).

" 8.—An oval autopore in transverse section (*H. dendroidea*) in which the pigment matter has assumed a dendroid appearance, the branches being composed more or less of stolons and spores in linear series—x 250 (about).

All the figures in this plate, and Figs. 7-9 in Plate IV., are from carefully executed drawings by Mr. Edgar R. Waite.

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1903.

1903.

1903.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 11.

NOTES ON THE COUNTRY
BETWEEN
EDJUDINA AND YUNDAMINDERA,
NORTH COOLGARDIE GOLDFIELD,

BY

A. GIBB MAITLAND,
GOVERNMENT GEOLOGIST.

WITH TWO MAPS.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

PERTH:
BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.
1903.

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I.—Geological Sketch Map of Yarri and Edjudina.
II.—Map of the Auriferous Quartz Reefs of Malcolm.

NOTES ON THE COUNTRY

BETWEEN

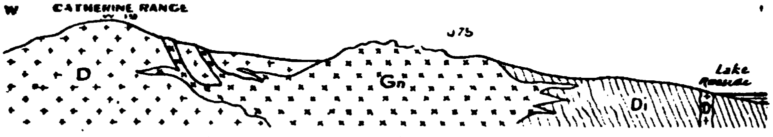
EDJUDINA AND YUNDAMINDERA.

GENERAL.

The country between Edjudina (Lat. 29° 44′ 40″ S.) and Yundamindera (The Granites) was examined by myself in the early part of the year. Leaving Niagara, the route *via* Yerilla was followed. No mining was going on at Yerilla, hence very little was to be seen of the conditions of affairs prevailing underground.

Mount Cay (W 11), a low though conspicuous rise, situated some distance to the south-west of the Yerilla townsite, is formed of a somewhat siliceous lateritic ironstone of the type prevailing in the district. No section was seen showing the rock upon which the bed rests.

To the south-eastward the Mount Catherine Range, upon the most conspicuous summit of which is situated Trig. Station W 19, consists of diabase. The diabase is intersected by dykes of granite as shown in a traverse from Catherine Range to Lake Raeside.



SECTION FROM CATHERINE RANGE TO LAKE RAESIDE

FIG. 1.

Some of these dykes pass gradually into coarse felspar porphyry (4426, 4423). Further to the eastward the granite gives place to greenstone schists, associated with which are bands of breccia (4398), which may possibly be of volcanic origin.

These greenstone schists are traversed by diabase (?) dykes, a good section of one of these being exposed in the cliffs surrounding a small rocky island in the bed of Lake Raeside, bearing 211° from Mount Catherine. The dyke exposed on the eastern side of the island has a strike of 255°, is vertical, and about three feet in thickness. There are no sections visible which clearly prove the relation which the dyke rocks bear to the massive diabase of Mount Catherine, though the impression left on the mind is that they are part of the same igneous mass, and that the greenstone schists are much older.

Near the lake some low bluffs show a thin covering of laterite resting upon the weathered greenstone.

The Mount Catherine Reef, which was opened up in the early days, stands out boldly upon the surface, with an average strike of 188 degrees. The reef, a pure white quartz, is vertical, and, as measured in the crosscut which had been put in across the vein some distance below the surface, attains a thickness of about 12 feet. The reef has a considerable horizontal extent.

From Yerilla to Yilgangi the road wends generally south-east but few, if any, sections of the underlying rocks are exposed *en route*. Between Yilgangi and the well about three miles west from Yarri (New Edjudina), no sections of the underlying rocks were visible.

YARRI (NEW EDJUDINA).

The mining centre of Yarri (or New Edjudina) is situated about six miles west of Edjudina. The relative situations of these will be found by a reference to the geological map attached to this report, or the lithograph (L 50) issued by the Department of Mines.

The country rock consists of a massive greenstone (diabase), some portions being very coarse in texture (4417), penetrated by bosses of granite (4421), from which dykes of aplite (4420) emanate. The Government well has been sunk in granite. The quartz reefs traverse both the granite and the greenstone, as is well shown on the geological map. The reefs occurring in the granite, however, are, when viewed as a whole, approximately parallel to one another, and trend generally north-west. The reefs in the greenstone strike at varying angles, although when their position is laid down on a map a general east and west trend may be detected.

Whatever may be the date of the intrusion of the granite, it is quite clear that the formation of the auriferous quartz reefs took place much later.

The matrix of the reef in the Wallaby G.M.L. 581 is a transmuted granite, an analysis of which is shown in the Table I. herewith. A microscopic examination of this granite shows that the rock has undergone considerable dynamic alteration.

TABLE I.

Analyses of Rocks.

Geological Museum Number	4,426	4,419	4,417	4,425
Specific Gravity	2·64	2·67	3·04	3·04
Silica, SiO_2	70·82	71·55	46·55	48·06
Carbonic anhydride, CO_2 ...	·40	*Nil*	Trace	1·03
Phosphoric anhydride, P_2O_5	Trace	Trace	·06	Trace
Titanic oxide, TiO_2	·35	·74	1·12	·90
Combined Water, H_2O ...	·27	·55	1·31	·59
Soda, Na_2O	5·57	4·98	1·50	2·50
Potash, K_2O	1·94	1·56	·33	·27
Magnesia, MgO	·87	1·07	9·80	6·67
Lime, CaO	2·20	1·79	10·56	11·37
Manganese protoxide, MnO...	·13	·39	·45	·59
Iron protoxide, FeO	1·73	1·58	8·79	10·37
Iron peroxide, Fe_2O_3 ...	·51	·77	3·19	·89
Alumina, Al_2O_3	15·56	14·82	15·36	16·21
Pyrites, FeS_2: Iron, Fe ...	·09	·13	Trace	·16
Sulphur, S ...	·11	·15		·18
Hygroscopic Water, H_2O ...	·05	·21	·29	·10
	100·60	100·29	99·31	99·89
Analyst ...	E. S. Simpson.	C. C. Williams.	E. S. Simpson.	E. S. Simpson.

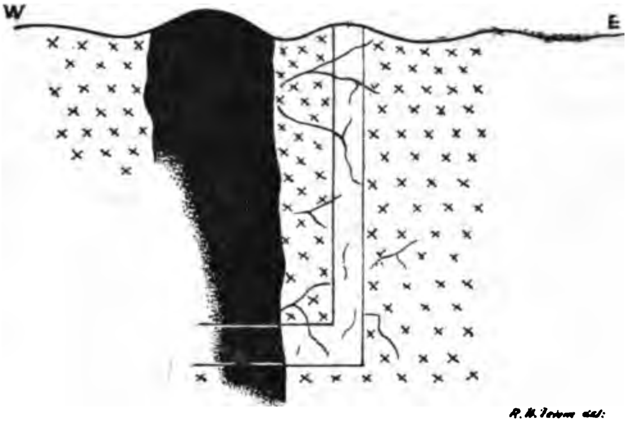
4426.—Felspar porphyry. Mount Catherine Range, Trig. W 19, Yerilla, North Coolgardie Goldfield.

4419.—Transmuted granite. Wallaby G.M.L. 581R. Yarri, North Coolgardie Goldfield.

4417.—Coarse diorite. Yarri, North Coolgardie Goldfield.

4425.—Diabase. Mt. Malcolm, Mt. Margaret Goldfield.

WALLABY NORTH G.M.L. 579R.—Near the southern end of the lease a vertical shaft has been sunk through granite to a depth of 60 feet, and from the bottom a drive has been put in for a distance of 10 feet, at which point the reef opened in the adjoining lease on the south was met with. The reef has been pierced for a distance of 14 feet, and at the date of my visit the whole thickness had not been ascertained. The rèef had a slight underlie to the east.



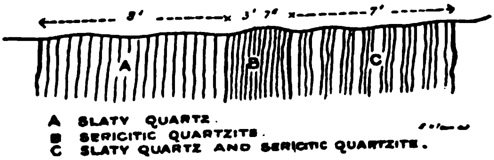
SECTION OF REEF IN THE WALLABY NORTH G.M.L.579R.

Fig. 2.

The country rock between the shaft and the reef is permeated with quartz leaders, which vary from $\frac{1}{4}$in. to $\frac{1}{2}$in. in thickness; some of these are said to contain more or less gold. In the shaft are a few veins of quartz intersecting the granite.

In June, 1903, 21 tons of ore from this lease yielded 21·80ozs. of gold, being at the rate of 1·04ozs. per ton.

Wallaby Central G.M.L. 580R.—The reef worked in lease 579R enters the Wallaby Central, and traverses the whole length of the property. At 285 feet from the southern boundary of 580R, a trench has been put in across the reef, and exposes a width of 24 feet of quartz. One hundred feet from the trench is another 18 feet in width, showing the following section:—



SECTION IN WALLABY CENTRAL G.M.L. 580R

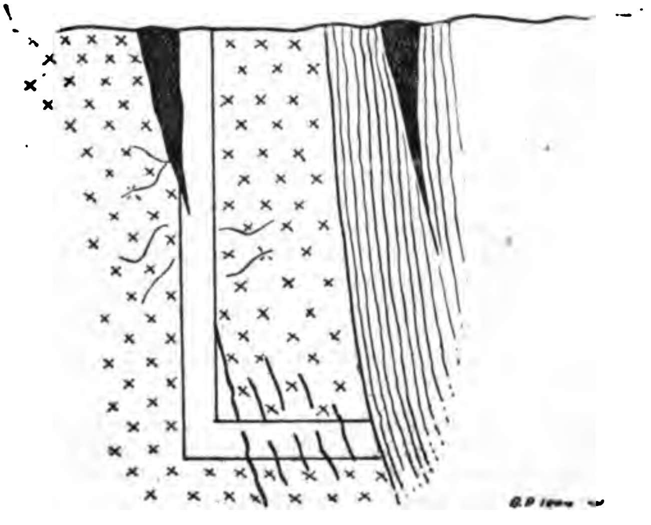
Fig. 3.

Distant 181 feet from the first-mentioned trench is a shaft 91 feet deep. The shaft, which has a slight underlie, has been put down on the foot-wall of the reef. Several leaders are passed through in the shaft. The owners of the property intend opening out on the reef when a depth of 100 feet has been attained.

Near the southern end of the lease a shaft has been put down to a depth of 35 feet, which, at the date of my visit, was inaccessible.

WALLABY G.M.L. 581R.—Upon this lease there are four distinct lines of reef outcropping, three of which traverse the whole length of the property from north to south. Operations at the date of my visit were confined to the easternmost reef, upon which three shafts had been sunk, known respectively as No. 1 shaft, Turner's, and No. 2 shaft.

The following section is exposed in No. 2 shaft, which is 418 feet from the north boundary of the lease:—

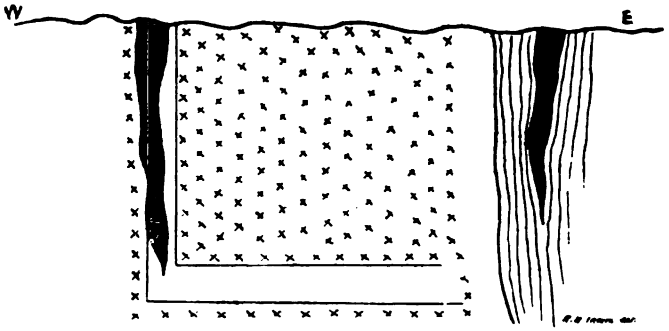


SECTION OF REEF IN N^{o}2 SHAFT WALLABY G.M.L.581^{R}

FIG. 4.

The shaft had been sunk to depth of 77 feet from the surface in granite. The bold reef peters out at a depth of 22 feet from the brace. From the foot of the shaft a crosscut has been carried 36 feet eastward, through a rudely foliated granite with quartz leaders along the planes of foliation; the crosscut has been carried along a joint for the whole distance.

What is known as Turner's shaft is situated 226 feet from No. 1 shaft. The shaft had been carried down to a vertical depth of 60 feet. The following section is exposed in the shaft:—



SECTION IN TURNER'S SHAFT WALLABY G.M.L. 581R

FIG. 5.

From the foot of the shaft a crosscut has been put for a distance of 65 feet, through nothing but transmuted granite, traversed by quartz leaders, running in all directions. The drive is said to be practically barren, assays yielding no gold. At the face of the crosscut the country rock is getting much harder, and carries a little pyrites. At the date of my visit the face of the crosscut was about 20 feet from the middle reef. Five feet north of Turner's shaft is what is known as No. 3 costeen, exposing 42 feet of quartz; 150 feet further south is No. 2 costeen, in which eight feet of quartz have been opened up; and 161 feet further is what is known as No. 1 shaft. This shaft has been sunk to a vertical depth of 55 feet; from the foot a crosscut goes to the east for a distance of 34 feet. The crosscut has been carried through transmuted granite, intersected by quartz veins ramifying in all directions; these, however, are said to carry no gold.

A costeen of 42 feet in length has been opened up 129 feet south of No. 2 shaft; it exposes 42 feet of quartz, which, however, only extends to a depth of three feet below ground. This crosscut is 325 feet from the southern boundary of the lease. The reef opened up extends along the surface for a distance of 900 feet within the boundary of the lease, and can be traced along the surface to the south through leases 582, 591, 587, and 585.

Wild Dog G.M.L. 582R.—Two shafts have been put down on the lease. The easternmost shaft has been put down on the underlie for a short distance, but very little stone is showing. The westernmost shaft is 25 feet in depth, and has been put down between two reefs, which are about 35 feet apart. From the foot of the shaft a crosscut has been put in to the west for a distance of feet.

Just at the mouth of the crosscut a quartz reef of about one foot in thickness was encountered, whilst at the face a little quartz is showing; but, from what can be seen, it does not appear to be very thick. The stone is said to assay from 17 to 18dwts. of gold to the ton. The eastern crosscut has been continued for a distance of 19 feet through nothing but transmuted granite of the usual type.

Record G.M.L. 587e.—The boundary between the granite and the diabase runs through the centre of this lease. The ground has been exploited by means of a vertical shaft 37 feet 6 inches in depth, and situated near the south-eastern angle of the lease.

The shaft has been sunk in decomposed diabase, and from the foot a drive has been put in to the west for a distance of 14 feet through nothing but country rock. The western drive, eight feet in length, traverses similar country. From a point 45 feet distant from the shaft, a costeen 199 feet in length has been opened out to the west, with the object of exposing the country. The deepest part of the costeen is four feet. No reef was located in the trench.

A crushing of 16·50 tons of stone from this lease during June, 1903, yielded 33·31ozs. of gold, being at the rate of 2·02ozs. per ton.

Queen's Birthday G.M.L. 585e.—A shaft has been sunk alongside the reef to a vertical depth of 50 feet. The reef, which is about 11 feet thick at the outcrop, trends practically north and south. The stone is a glassy quartz, of the nature which seems characteristic of the reefs in the diabase country of this district; the stone carries a little iron pyrites. It is intended to put in a crosscut at the foot of the shaft to intersect the reef at that depth.

A trial crushing of 10 tons from this reef during 1902 yielded gold at the rate of 23ozs. 18dwts. to the ton of quartz. The official records show that 33 tons were crushed during the early part of 1903 for 105·00ozs., being at the rate of 3·18ozs. per ton.

Queen's Birthday South G.M.L. 614e.—Towards the northern end of the lease a shaft had been put down to a vertical depth of about 48 feet. At the foot of the shaft there is about one foot of quartz of the usual type showing. Near the southern boundary of the lease is a shallow prospecting shaft about 24 feet deep; but, beyond a few irregular quartz stringers, no reef appears to have been met with in sinking.

Sixty tons were crushed from this lease during April, 1903, for 39·87ozs. of gold, being at the rate of ·66ozs. per ton.

Novitiate G.M.L. 630e.—A shaft has been sunk vertically through diabase country for a depth of 27 feet 6 inches. At 22 feet is a small quartz leader; from the foot of the shaft a drive goes east about 15 feet, and exposes a quartz vein of about six inches, dipping to the east at an angle of 45 degrees.

19·25ozs. of gold were obtained from specimens from this mine during 1902.

WISE STEP G.M.L. 641E.—A vertical shaft had been put down to a depth of 37 feet 6 inches through diabase country. The owners of the property contemplate continuing the shaft to a depth of 80 feet with the object of intersecting the reef, which outcrops at 44 feet from the shaft, by means of a western crosscut.

BEATRICE G.M.L. 632E (376E).—Upon this property there are five distinct quartz veins outcropping; several shafts have been sunk, and a fair amount of work carried out.

On what may be called the main reef two shafts have been sunk about 155 feet apart. The northernmost shaft, No. 1, has only attained a vertical depth of 23 feet. At the south end of the shaft there are about 6 to 18 inches of quartz showing. At about 10 feet from the surface a fair amount of work has been done, and a good deal of stone taken out. A drive has been put in about 15 feet to the south; just where the drive leaves the shaft about a foot of quartz is exposed, and at the face a like thickness of glassy quartz. From this shaft about 14 tons of quartz crushed about 18dwt. to the ton at the Neta battery at Edjudina. The south, or No. 2, shaft has a vertical depth of 37 feet. The reef exposed is vertical. From the outcrop, near the shaft, about 50 ounces of gold have been dollied by the previous holders of the ground some years ago. At the southern end of the shaft a drive has been put in for about 10 or 12 feet, and at the face about two feet of quartz is showing. Eighteen inches of quartz is showing at the north side of the shaft. About 50 feet north of the shaft the reef has been worked from the surface down to a depth of about 20 feet by the previous holders of the ground.

What is known as the western reef lies some distance from the one last described. Its position is fixed by the following bearings:—No. 1 shaft, 89°; No. 2 shaft, 127°. This reef has been worked by the previous owners of the property. A shaft has been put down to a depth of about 34 feet, on a slight easterly underlie. From the foot of the shaft a drive 10 feet north shows:—

Diabase; quartz, three inches; formation, eight inches; quartz, nine to ten inches; diabase. At the south end of the shaft the following is exposed:—Diabase; quartz, six inches; formation, six inches; quartz, 14 inches; diabase.

About 80 feet to the west of this is another, which has just been opened on the surface; no work has been done upon it. Sixty feet east of the main reef is another parallel vein having a width of from 12 to 13 feet, as shown on the surface. Beyond laying bare the stone no further work has been done.

The following are the official returns from this lease:—

BEATRICE G.M.L. 622R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	14·00	13·10	0·93
1903 to 30th June ...	24·00	21·31	0·89
Total	**38·00**	**34·41**	**0·91**

To the south of this lease is a claim (not shown on the map) held by Messrs. Byers and Co. An underlie shaft has been put down to the east, at an angle of about 45 degrees, for a distance of 15 feet. The shaft had been sunk upon a vein of about five inches in thickness, which, however, had petered out at the foot of the shaft. The country rock is diabase of the type prevailing in the district.

A traverse from Yarri to Mount Walbrook (W 9) showed the staple formation, after getting clear of the granite, to consist of greenstone schists, and the large quantity of quartz *débris* with which the surface was strewn in places seemed to indicate that there must be quartz veins associated with the schists.

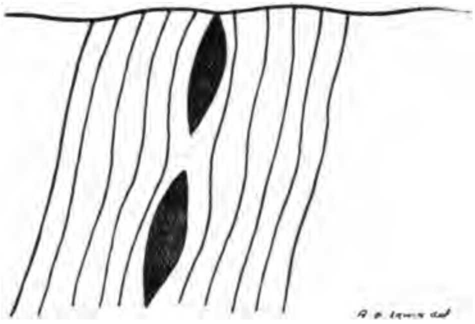
Mount Walbrook consists of a ridge of laminated quartzite, striking 333°. The quartzite is about 8 to 10 feet thick, and is vertical; it carries a little brown hematite of the usual type.

The granite of Yarri gives place to greenstone schist as the mining centre of Edjudina is approached.

EDJUDINA.

The mining centre of Edjudina is of interest in that a virtually continuous line of reefs has been proved to extend in a north-west and south-east direction for a distance of about 10 miles, and has been worked more or less along the whole line. The width of the belt embracing the auriferous quartz reefs nowhere exceeds 20 chains.

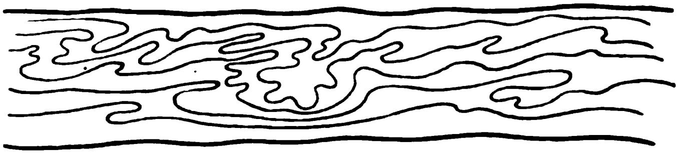
So far as may be seen the reefs consist of exceptionally lenticular veins of quartz occurring along the planes of foliation of the schist, thus :—



SECTION SHEWING THE MODE OF OCCURRENCE OF THE EDJUDINA QUARTZ REEFS.

Fig. 6.

About two miles to the north-east, and parallel to the auriferous quartz reefs, is a long razor-backed ridge formed of the laminated hematite-bearing quartzites (cherts ?) which can be followed for about 15 miles in the vicinity of Edjudina. The width of this belt of laminated quartzite is about 15 chains, and it is made up of a series of remarkably attenuated lenses, each of great horizontal extent. Several bands of quartzite occur within a few chains on either side of the auriferous quartz reefs, and can be followed with very little interruption along the known extent of the auriferous series. Wherever these quartzites can be seen in sections, they are either vertical or are inclined at high angles to the north-east, no lower dip than 68° having been observed. The ridge upon which Yabboo Hill (E 36) is situated extends for about five or six miles, and is made up of three bands of hematite quartzite. The band upon which the trig. station has been built is the most ferruginous. The central band is about 10 to 15 feet thick, and very much contorted thus :—



CONTORTED HEMATITE QUARTZITE
YABOO HILL

Fig. 7.

The quartzites are all enclosed in a slaty cleaved rock, of a nature which it is impossible to determine owing to the extensive surface decomposition it has undergone. The rock, however, has the appearance of being a bleached greenstone schist. The southern end of the ridge disappears gradually into the low ground to the south. The summit of Yabboo Hill (E 36) is by aneroid 200 feet above the trig. station E 35 at Edjudina soaks.

The laminated quartzites range from an almost pure quartz, through varieties of beautifully banded jaspers, to what appears to the eye to be a practically pure hematite.

Table II. gives analyses of six typical varieties of the Edjudina iron ores.

TABLE II.

Analyses of Iron Ores from Edjudina (by E. S. Simpson).

Geological Museum Number.	4401.	4402.	4403.	4404.	4406.	4408.
Metallic Iron, Fe	37·38	25·86	26·69	33·45	38·33	22·85
Silica, SiO_2	45·05	60·82	59·55	51·76	43·10	61·19
Sulphuric anhydride, SO_3	·08	·067	·096	·085	·062	·092
Phosphoric anhydride, P_2O_5	·10	·138	·082	·100	·147	·198
Hygroscopic Water, H_2O	·17	·12	·05	·11	·12	·23
Combined Water, H_2O ...	·49	·87	·74	1·08	·93	4·24
Action on compass	None	None	Strong	None	None	None

4401—Banded hematite, E36, Yabboo Hills, Edjudina, N. Coolgardie G.F.

4402—Banded hematite quartzite, Yabboo Hills, Edjudina, N. Coolgardie G.F.

4403—Banded quartzite with hematite and magnetite, Cairn C., Yabboo Hills, Edjudina, N. Coolgardie G.F.

4404—Banded hematite, Cairn C., Yabboo Hills, Edjudina, N. Coolgardie G.F.

4406—Banded hematite, Hill B., Yabboo Hills, Edjudina, N. Coolgardie G.F.

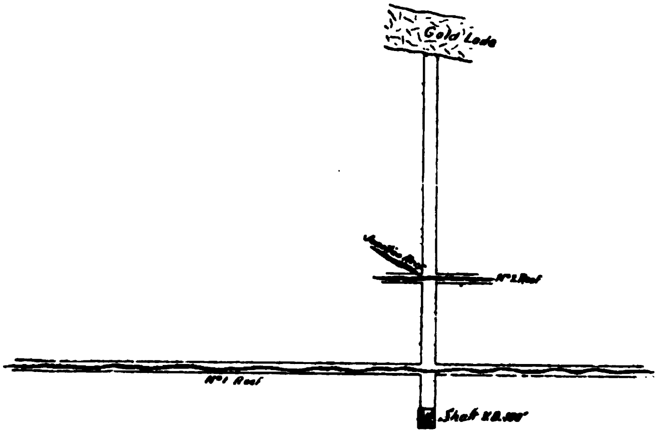
4408—Ferruginous quartzite, Hill A., Edjudina, N. Coolgardie G.F.

These analyses demonstrate that, contrary to the appearance of the ores themselves, they all contain a high percentage of silica and a relatively low percentage of iron. With the single exception of the last (4,408), they could be readily concentrated to high-grade ores. Although the percentage of sulphur is low, the phosphorus would seem to be too high for what is considered a requisite for the production of steel by the usual acid Bessemerprocess.

The following is a description of such of the mines along the Edjudina line as were open to inspection:—

NETA G.M.L. 401E (361E).—The Neta lease is being worked by a vertical shaft 100 feet deep, and two levels have been opened out. From the foot of the shaft a crosscut goes west for a distance of 21 feet to what is known as No. 1 reef, upon which most of the work on the property has been concentrated.

The reef has been opened out to the southward for a distance of 200 feet at the 100 feet; the quartz is of the usual irregular type. Thirty-nine feet to the west of No. 1 reef is another known as No. 2, but at the date of my visit not much work had been done on it. One hundred and six feet further west is what is known as the "Gold lode," 20ft. 4in. in width. The "lode" is merely a band of decomposed country rock intersected by very thin veins of quartz and ironstone.



SKETCH PLAN OF THE NETA MINE G.M.L. 401R

FIG. 8.

At the 50-feet level No. 1 reef is 22 feet from the shaft; 47 feet further west of it is No. 2 reef. In the crosscut, at 50 feet from the shaft, are two or three veins of quartz separated by narrow bands of a foliated sericitic rock.

The reef worked in this property can be followed northwards along the surface through leases 411 and 412.

The official records show that up to the close of 1902 3,202·5 tons of ore from this mine yielded 4,918·39ozs. of gold, as follow :—

NETA G.M.L. 401R (361E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	584·00	751·50	1·28
1899	1,165·50	1,549·49	1·32
1900	380·00	1,022·10	2·69
1901	145·00	318·20	2·19
1902	928·00	1,277·10	1·37
1903 to 30th June ...	811·00	1,004·80	1·23
Total	**4,013·50**	**5,923·19**	**1·47**

Senate G.M.L. 539r.—The reef opened up in the Senate is in all probability the same as the Neta. The Senate reef has been worked by a vertical shaft 113 feet deep, situated close to the southern boundary of the lease.

At the foot of the shaft the reef has been opened up by a drive put in 120 feet to the north and 200 feet southwards. At the face of the northern drive about six to eight inches of quartz is exposed, but the average width is about 18 inches. To the face of the southern drive the reef is continous, with some interruptions, but is very thin.

The official records show that 524·9ozs. of gold were obtained during 1902 by crushing 259 tons of ore, being at the rate of 2·02ozs. per ton.

Gawler G.M.L. 497r (365e): The main shaft on this property is 100 feet deep. From the foot of the shaft a drive has been put in about 200 feet, which shows about one foot of quartz at the face. At about 170 feet from the shaft is a quartz lens of about three feet in thickness, but no great horizontal extent. The north drive has been carried about 200 feet, but at the date at which the mine was visited there was no stone showing in the face.

The official records show that up to the end of 1902 206 ounces of gold were obtained by crushing 130 tons of stone, as follow :—

Gawler G.M.L. 497r (365e).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	50·00	88·00	1·76
1902	80·00	118·00	1·47
Total	**130·00**	**206·00**	**1·58**

Fingall G.M.L. 366.—The outcrop of two well-defined reefs traverse practically the whole length of the lease, but at the date of my visit work had evidently been abandoned for many years, and nothing could be seen. There are three shafts on the lease, and all the evidence seems to point to the fact that a good deal of work must have been done on the property.

Welshman G.M.L. 368e (590r) (Louie Mary).—Upon this lease there is only one shaft in which work is going on. The shaft is 50 feet in depth, and operations were being carried out at 12 feet from the bottom. From the bottom of the shaft a crosscut of 120 feet in length, driven on a bearing of S. 50° W., connects with what was the old main shaft. Nothing, however, is showing in the crosscut. East from the shaft there is a small quartz reef exposed and at the face another of about 8 inches in thickness. The following are the official returns for this lease:—

LOUIE MARY G.M.L. 501E (368E.)

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	105·00	230·65	2·19
1901	25·00	30·00	1·20
Total	**130·00**	**260·65**	**2·00**

VULCAN G.M.L. 369E (667E).—No work was being carried out on the lease, and the shaft being inaccessible no description of the deposit can be given. From the material lying in the dump, it may be conjectured that the country rock encountered in sinking is greenstone schist of the usual type. A few yards west of the western boundary of the lease the surface is covered with fragments of hematite-quartzite of the type prevailing on the ridge to the west of the Neta battery. In all probability this band is the continuation of that which is virtually continuous as far as the Old Edjudina and Glengarry mines to the south.

The following returns have been recorded from this lease:—

VULCAN G.M.L. 667E (369E.)

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	90·00	58·05	·64
1901	160·00	126·30	·79
Total	**250·00**	**184·35**	**·73**

GOLDEN GIRL G.M.L. 370E (588E).—There is a line of shafts along the reef on the western boundary of the property, but these were inaccessible to me. The following are the official returns from this area:—

LORD NELSON G.M.L. 512E (370E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	50·00	62·50	1·25
1901	188·00	167·20	·89
Total	**238·00**	**229·70**	**·96**

Golden Girl G.M.L. 588R (370E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	21·00	21·70	1·03
1903 to 30th June ...	40·00	67·50	1·69
Total	**61·00**	**89·20**	**1·46**

Enterprise G.M.L. 589R (371E, 604R).—Previously called Big Ben (506R). Four quartz reefs of the prevailing type traverse the lease. A well-defined reef traverses the eastern boundary of the lease, which has been opened up in several places, and a good deal of stone raised from a depth of about 10 feet. In an open cut about five feet of quartz is exposed. The reef can be followed, with a few interruptions, to the southern boundary, where it enters the adjoining lease at 126 feet from the south-east angle of 371. An open cut about 60 feet in length exposes a good thickness of quartz of the prevailing type. At the boundary between G.M.L.'s. 371 and 372 the reef has pinched out to about two inches. A maximum thickness of about four feet of quartz is now visible in the open cut, which in its deepest part attains a depth of 13 feet.

A little distance to the west of the open cut a shaft about 20 feet in depth was, at the date of my visit, being sunk by the holders of the ground. The shaft was sunk in greenstone schist, with the object of following down a very small quartz leader.

The main shaft has been sunk to a vertical depth of 80 feet. From the foot of the shaft the reef has been driven on for a distance of 200 feet north, at which point it pinched out. A crosscut 24 feet in length connects with another shaft to the east. This shaft is 80 feet in depth, and has been carried down through greenstone schist of the prevailing type. The reef in the first-mentioned shaft has been driven on for a distance of about 100 feet in a southerly direction. At the face of the drive there are about 12 inches of quartz showing; it contains small quantities of carbonate of iron. The maximum width of quartz in the south drive is three feet six inches. The reef, however, is of lenticular habit, lens succeeding lens, being connected by threads of quartz.

Near the northern boundary of the lease a shaft has been put down to a depth of about 10 feet, with the object of prospecting two reefs about four feet six inches apart. The foot-wall reef is about from six to eight inches thick, and the hanging-wall vein three to four inches.

The following crushings have been recorded from this lease:—

BIG BEN G.M.L. 506R AND ENTERPRISE G.M.L. 589R.

Year.	Ore crushed.	Gold therefrom	Rate per ton.
	tons.	ozs.	ozs.
1900	30·00	9·00	·30
1903 to 30th June ...	22·00	13·00	·59
Total	**52·00**	**22·00**	**·42**

HEATHCOTE G.M.L. 372.—No work was going on at the date of my visit, and the main shaft had been partly filled up. A good deal of quartz is lying round the mouth of the shaft. In 1900, 72 tons of stone were crushed for 38ozs. gold, being at the rate of ·53oz. per ton.

M.A. 3 lies within what was originally known as G.M.L. 373. A deep shaft, at present inaccessible, occurs on this ground, but no particulars are obtainable in connection with it. There are also the remains of an old three-head battery, said to have been erected for crushing the dumps left by the previous holders of the ground.

ECLIPSE G M.L. 373.—A vertical shaft is at present being sunk; and at the date of my visit had attained a depth of 30 feet. The shaft was put down with the object of intersecting a reef outcropping a little distance to the west.

PERSEVERANCE G.M.L. 374 (613R).—There are two shafts on the lease; the southernmost is inaccessible; the northern is 73 feet deep. The reef, which occurs along the foliation planes of greenstone schist, has a maximum thickness of three feet six inches The reef has been opened up by drives 50 feet in length on the north, and a similar length to the south. The quartz is the usual bunchy lenticular type.

The official records show that during 1902 24 tons of stone were crushed for a yield of 40ozs. of gold from this lease, being at the rate of 1·66ozs. per ton.

THREE BROTHERS G.M,L. 383 (599R).—There are three reefs on this property. The most northerly shaft (1), sunk on the line of the largest reef, was inaccessible; hence no description of the workings can be given.

The western shaft (2), sunk on the middle reef, had been put down to a depth of 75 feet, and a drive 18 feet to the south had been opened out. There was only an inch or two of quartz, dipping at an angle of 68 degrees to the east. Shaft (3), situated in the south-east angle of the lease, was inaccessible.

The fourth shaft, situated about 80 feet south of No. 2, had been carried down to a depth of 75 feet vertically below the surface.

From the foot of the shaft drives had been put in north and south along the reef. The northern drive is about 30 feet in length, and shows 16 inches of quartz at the face.

Scotchman G.M.L. 384 (566R).—There are two lines of reef outcropping on this lease, and they are continuous throughout the whole length of the property, and extend as far to the southward as G.M.L. 274E.

The following are the official returns from this lease:—

Scotchman G.M.L. 566R (384E).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	131·00	112·50	·86
1903 (to 30th June) ...	110·00	77·25	·70
Total	**241·00**	**189·75**	**·79**

G.M.L. 274E.—A good deal of work has been done on this lease, and a fair quantity of stone raised; but at the date of my visit the workings were inaccessible, hence little could be seen.

G.M.L. 273E.—A well-defined quartz reef outcrops along the western boundary of the lease. The reef, as exposed in a trench, is about 32 feet thick.

Try It G.M.L. 272E (665R).—What is probably the same reef as that outcropping in the adjoining lease on the north traverses this property, but very little work has been done upon it.

During the early part of 1903, 21 tons of ore from this lease yielded 9·08 ounces of gold, being at the rate of ·43 ounces per ton.

G.M.L. 271E.—A quartz reef of about three feet in thickness makes a bold outcrop at a point about 55 feet from the north-west angle of the lease, and a shaft, now inaccessible, has been put down on it. At about 200 feet from the south-east angle there is an excavation about six feet in depth.

G.M.L. 270E.—There are three parallel reefs traversing this property. Near the south-west angle of the lease is a line of old and inaccessible shafts put down along the strike of the westernmost reef. Parallel to this, and close to the north-eastern boundary of the lease, is another equally persistent line of reef, which has been opened up by open cut along its strike. The stone is of the character prevailing in the district, and occurs in the form of lenses enclosed in a casing of sericite schist.

Bella G.M.L. 275E (609R).—There are three distinct lines of reef traversing the lease, the eastern and western being those which extend from the adjoining ground in the north.

A vertical shaft 50 feet in depth was being sunk at the date of my visit. On the northern face of the shaft the quartz reef attained a thickness of three feet. Gold was shewing freely in the stone lying at grass. A good deal of work had been done by the previous holders of the ground. The official statistics show the following crushings from this lease:—

BELLA G.M.L. 275E (609R).

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	64·00	105·70	1·65
1901	160·00	200·00	1·25
1903 (to June 30th)...	206·50	212·50	1·03
Total	**430·50**	**518·20**	**1·20**

CROW'S NEST G.M.L. 277E (576R).—The reef worked on this property is the same as that opened out in the Bella, to the north. The present working shaft, near the northern boundary of the lease, is 30 feet deep, and shows 3ft. 6in. of quartz at the foot.

The adjoining shaft to the north, 80 feet distant on the same reef, has been put down to a depth of 50 feet; and the stone has been stoped out to the surface. The reef has been driven on for about 120 feet. There are about 160 tons of quartz lying at grass, some of which shows gold freely.

A good deal of work seems to have been carried out along the outcrop of a reef outcropping close to the south-western boundary. This reef extends into the adjoining lease to the south.

The following crushings are recorded from this lease:—

CROW'S NEST G.M.L. 576R.

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1902	55·00	63·00	1·14
1903 (to 30th June)...	112·00	160·00	1·43
Total	**167·00**	**223·00**	**1·33**

G.M.L. 276.—The reef has been worked by means of a vertical shaft, which was inaccessible to me. Judging from the paddock of stone lying at grass, the reef must have been about 2ft. 6in. thick in places.

Parallel to this reef, and about 470 feet east, is another, which makes a characteristically bold outcrop on the surface. The width of the reef is about three feet six inches, but although it can be followed for a considerable distance along the outcrop, it does not pear to have been much worked.

G.M.L. 321.—A shaft has been sunk to a vertical depth of 25 feet, and a quartz reef of about two feet six inches in thickness exposed.

Triumph G.M.L. 322E (605R).—The most southerly shaft on the lease was at work at the date of my visit. The reef opened up on the adjoining property on the north can be followed through the lease on a bearing of 147 degrees. Parallel to this reef is another to the east, upon which work was being carried on at the date of my visit. The vertical shaft had attained a depth of 35 feet. The reef is practically vertical, though with a perceptible underlie to the east. The reef is of the usual lenticular character. The easternmost shaft on the property had been carried down to a depth of 20 feet; the country rock has a slight dip to the east. On the foot wall of the reef is a very thin band of platey fissile quartzite. Adjoining this shaft on the north, and on the same line of reef, another shaft had been carried down to a depth of about 50 feet, and about 35 feet of stoping done on either side of the shaft. At the foot of the shaft the country rock underlies east at an angle of 65 degrees. About 50 tons of ore have been raised from this reef.

Old Edjudina Mine G.M.L. 323E (623R).—A deep shaft, now inaccessible, apparently passed through little else than what appears to be a sericite schist. In the dump were several pieces of stone, showing irregular patches of quartz, encased between the laminae of the schist. The quartz contained a little iron pyrites and iron carbonate, and is evidently, as seems to be the case with most of the reefs, in the form of lenticules along the planes of schistosity. Judging by the size of the dump and the numerous small shafts, a good deal of work must have been done at one time or another.

Glengarry G.M.L. 493E (502R).—The main shaft on the lease had been carried down to a depth of about 150 feet. At 75 feet the reef had been opened up, and stoped out to the surface. Judging by the open cuts on the surface, a fair amount of work must have been carried out. The mine being practically under water, very little was to be seen of the nature and character of the reef. During 1901, 395ozs. of stone were crushed for 243·50ozs. of gold, being at the rate of ·68ozs. per ton.

The Edjudina belt of hematite-bearing quartzites are continuous northwards across Lake Reside through Mounts Millicent W 15, and Howe W 14.

GOLD YIELD OF THE EDJUDINA DISTRICT.

Year.	Ore Crushed.	Gold therefrom.	Rate per ton.
Aerie G.M.L. 655R.			
	tons.	ozs.	ozs.
1903 (to 30th June) ...	38·00	55·00	1·44

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom	Rate per ton.
ALPHA G.M.L. 681R.			
	tons.	ozs.	ozs.
1903 (to 30th June) ...	**20·00**	**16·70**	**·83**
ANGLO SAXON G.M.L. 204R.			
Previous to 1898 ...	**28·00**	**23·50**	**·84**
BEATRICE G.M.L. 622R.			
1902	14·00	13·10	·93
1903 (to 30th June) ...	24·00	21·31	·88
Total	**38·00**	**34·41**	**·90**
BELLA G.M.L. 527R.			
1900	64·00	105·70	1·65
1901	160·00	200·00	1·25
1903 (to 30th June) ...	206·50	212·50	1·03
Total	**430·50**	**518·20**	**1·20**
BIG BEN G.M.L. 506R.			
1900	**30·00**	**9·00**	**·30**
BRILLIANT G.M.L. 513R.			
1901	**30·00**	**57·55**	**1·92**
BROKEN HILL G.M.L. 610R.			
1902	40·00	35·70	·89
1903 (to 30th June) ...	35·00	19·30	·55
Total	**75·00**	**55·00**	**·73**
BROKEN HILL NORTH G.M.L. 611R.			
1903 (to 30th June) ...	**17·00**	**4·86**	**·28**
CHEETARRA G.M.L. 676R.			
1903 (to 30th June) ...	**25·00**	**2·11**	**·08**

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued*.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
CONCORDIA G.M.L. 545R.			
	tons.	ozs.	ozs.
1902	**28·00**	**9·40**	**·33**
CROW'S NEST G.M.L. 576R.			
1902	55·00	63·00	1·14
1903 (to 30th June) ...	112·00	160·00	1·43
Total	**167·00**	**223·00**	**1·33**
ENTERPRISE G.M.L. 589R.			
1903 (to 30th June) ...	**22·00**	**13·00**	**·54**
EVA G.M.L. 522R.			
1902	29·00	57·00	1·96
1903 (to 30th June) ...	29·00	57·00	1·96
Total	**58·00**	**114·00**	**1·96**
GAWLER G.M.L. 497R.			
1901	50·00	88·00	1·76
1902	80·00	118·00	1·47
Total	**130·00**	**206·00**	**1·58**
GLENGARRY G.M.L. 502R.			
1901	**359·00**	**243·50**	**·68**
GOLDEN GIRL G.M.L. 588R. (late LORD NELSON G.M.L. 512R.).			
1900	50·00	62·50	1·25
1901	188·00	167·20	·89
1902	21·00	21·70	1·03
1903 (to 30th June) ...	40·00	67·50	1·69
Total	**299·00**	**318·90**	**1·06**
HEATHCOTE G.M.L. 503R.			
1900	**72·00**	**38·00**	**·53**

Gold Yield of the Edjudina District—*continued*.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
Highland Mary G.M.L. 573r.			
	tons.	ozs.	ozs.
1902	**46·00**	**52.50**	**1·14**
Louie Mary G.M.L. 501r.			
1900	105·00	230·65	2·20
1901	25·00	30·00	1·20
Total	**130·00**	**260·65**	**2·00**
Lyon Glen G.M.L. 677r.			
1903 (to 30th June) ...	**84·00**	**108·70**	**1·29**
Maid Marion G.M.L. 653r.			
1902	**17·00**	**13·00**	**·76**
Mt. Eiversley G.M.L 460r.			
1899	**55·00**	**61·00**	**1·11**
Neta G.M.L. 401r.			
1898	584·00	751·50	1·28
1899	1,165·50	1,549·49	1·33
1900	380·00	1,022·10	2·69
1901	145·00	318·20	2·19
1902	928·00	1,277·10	1·37
1903 (to 30th June) ...	811·00	1,004·80	1·24
Total	**4,013·50**	**5,923·19**	**1·47**
Neta Extended G.M.L. 418r.			
1899	104·00	118·18	1·13
1900	622·50	681·90	1·09
1901	456·00	863·70	1·89
Total	**1,182·50**	**1,663·78**	**1·40**
Ninety-nine G.M.L. 459r.			
1899	**30·00**	**10·45**	**·35**

GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
OUTCAST G.M.L. 523R.			
	tons.	ozs.	ozs.
1900	30·00	41·60	1·38
1901	30·00	29·00	·97
Total	**60·00**	**70·60**	**1·17**
PERSEVERANCE G.M.L. 613R.			
1902	**24·00**	**40·00**	**1·66**
QUEEN'S BIRTHDAY G.M.L. 585R.			
1903 to 30th June ...	**33·00**	**105·00**	**3·18**
QUEEN'S BIRTHDAY SOUTH G.M.L. 614R.			
1903 to 30th June ...	**60·00**	**39·87**	**·66**
RECORD G.M.L. 587R.			
1903 to 30th June ...	**16·50**	**33·31**	**2·02**
RETURN G.M.L. 680R.			
1903 to 30th June ...	**25·00**	**16·50**	**·66**
ROCKY RIDGE G.M.L. 679R.			
1902	**8·00**	**10·30**	**1·29**
SCOTCHMAN G.M.L. 566R.			
1902	131·00	112·50	·86
1903 to 30th June ...	110·00	77·25	·70
Total	**241·00**	**189·75**	**·79**
SENATE G.M.L. 539R.			
1902	**259·00**	**524·90**	**2·02**
TRIUMPH LEASES, LTD., G.M.L.S 13/8R, 244/5R, 308R.			
Previous to 1898 ...	1,747·00	1,648·00	·94
1898	515·00	565·30	1·09
Total	**2,262·00**	**2,213·30**	**·97**

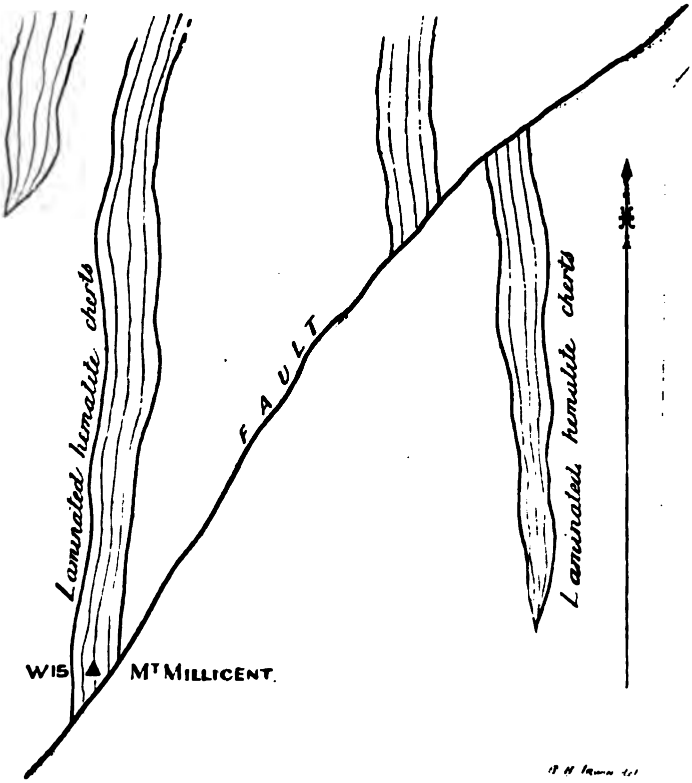
GOLD YIELD OF THE EDJUDINA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
TRY-IT G.M.L. 665R.			
	tons.	ozs.	ozs.
1903 to 30th June ...	**21·00**	**9·08**	**·43**
UNDAUNTED G.M.L. 510R.			
1901	**65·00**	**64·35**	**·99**
VULCAN G.M.L. 498R.			
1900	90·00	58·05	·64
1901	160·00	126·30	·79
Total	**250·00**	**184·35**	**·73**
WALLABY NORTH G.M.L. 579R.			
1903 to 30th June ...	**21·00**	**21·80**	**1·04**
SUNDRY CLAIMS AT EDJUDINA.			
1899	75·00	72·30	·96
1900	57·00	54·52	·95
1901	381·00	352·14	·92
1902	283·00	338·30	1·19
1903 to 30th June ...	32·00	105·00	3·28
Total	**828·00**	**922·26**	**1·11**

Mount Millicent (Reedy's Bluff) rises to a height of about 450 feet above the level of the surrounding country. The quartzites (4633, 4634) of the summit present all the usual gradations between a practically pure quartz rock, through beautifully ribboned jaspers to a laminated hematite quartzite. As is the case at Edjudina, the belt is formed of two or three bands of quartzite, at varying distances apart, one band lying about two miles to the east of the main belt. The highest ridge of the Mount Millicent group is formed of a brecciated form of the hematite quartzite; the brecccia (fault rock) being formed of angular fragments of quartzite, jasper, and hematite, cemented together by secondary silica. Many of the bands are minutely puckered and contorted between their walls, though it is only occasionally that their place is taken by breccias. All the available evidence seems to indicate that these lines or bands of quartzite have been formed along sheer planes, and that faulting took place subsequently to the deposition of the iron ores themselves.

At the summit of Mount Millicent the hematite quartzites are very highly contorted and puckered, and have a dip of, in one place, 65 degrees to the north-east.

In addition to movement along the line of the quartzites, a section in the vicinity of Mount Millicent shows an excellent example of the sudden truncation of a quartzite band, by a vertical fault bearing 124 degrees. The contorted quartzite ends abruptly in a perfectly smooth wall, about 10 or 20 feet in height, and is shifted to the west for several feet. This fault, which is shown in the accompanying section, is probably responsible for the truncation of the band which forms Mount Millicent.



PLAN OF NEIGHBOURHOOD OF M^T MILLICENT

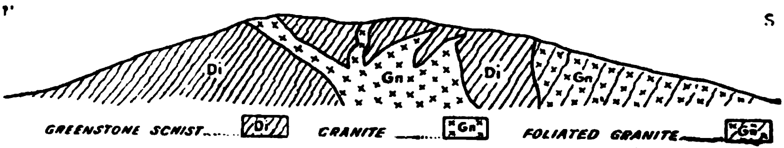
NOT TO SCALE

Fig. 9.

Somewhat similar brecciated and contorted hematite quartzites are continuous to Mount Howe, W14, which rises, according to aneroid measurements, to an altitude of about 500 feet above the surrounding country. The belt has a general strike of 163 degrees, and is continuous for about 10 miles to the north, where it is crossed by the main road from the Quartz Blow Soaks to Linden. Here the quartzites are encased in a decomposed slatey rock, which there are good grounds for believing to be merely bleached forms of the greenstone schists which make up the country on either flank of the ridge.

West of Mount Howe (W14) is Mount Percy (E67), which rises to a height of 530 feet above the level of the plains.

A low though conspicuous rise about five miles east of Mount Percy, and bearing 308 degrees therefrom, shows a section which seems to demonstrate the relation which the granite rock bears to the greenstone and allied basic rocks.



SECTION NEAR Mt PERCY
Fig. 10.

This low rise is made up of greenstone, which has been rudely foliated or cleaved, along a bearing of 119 degrees. This has been invaded by dykes of a fine-grained granite rock (4636). Near the northern end of the rise the surface is occupied by a foliated granite, the strike of the foliation planes being parallel with those of the neighbouring greenstone. This section is of importance in that it seems to indicate that there are granites of two totally distinct geological ages in the district.

Mount Percy (E67) forms one of the highest summits of a fairly extensive series of hills, drained by numerous gullies, which all discharge their waters into Lake Raeside. The mount, as well as the whole of the hills, is formed of diabase (4637), intersected by dykes of granite of the usual type. These dykes, doubtless, emanate from that extensive mass of granite which extends from Yundamindera to Quartz Blow Soaks, and Mount Catherine.

LINDEN.

The mining centre of Linden, at present practically at a standstill, lies about eight or nine miles to the east of the Edjudina and Camel Back Soak belt of iron-bearing quartzites. The productive centre lies just along the junction of the greenstones and allied rocks with the granite, which may form part of the Quartz Blow Soak mass.

Mount Linden (W8), which rises to 140 feet above the plains, is formed of bands of ferruginous quartzite (4626), striking 320 degrees and dipping north at an angle of about 50 degrees. The quartzite (chert?) is seamed with veins of secondary silica.

The following are the particulars of such of the properties as were open to inspection at the date of my visit:—

Great Carbine G.M.L. 406r.—This property is situated some distance to the south of Mount Linden and beyond the limits of the Mines Department lithograph L28.

The reef, which has been worked, has a strike of 267 degrees and underlies to the north at a high angle. A vertical shaft has been sunk to a depth of 50 feet; on the eastern face of the shaft, and at the foot, there is a quartz reef about two feet in thickness exposed. This reef has been worked for about 50 feet along the strike; at the western face of the drive there is about 18 inches of quartz. The reef has been practically all stoped out to the surface from the 50 feet level.

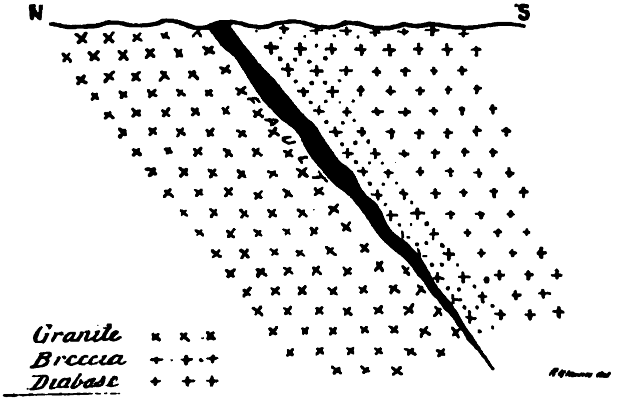
Free gold can be seen in some of the quartz, in addition to a little pyrites. From this reef 294 tons of quartz crushed have been officially reported as yielding 178·2 ounces of gold, as follows:—

Great Carbine G.M.L. 406r.

Year.	Ore treated.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	36·00	42·70	1·18
1899	5·00	7·25	1·45
1900	253·00	128·25	·50
Total	294·00	178·20	·60

Golden Ridge (Federal) G.M.L. 3314.—This property was not at work at the date of my visit, and had evidently been abandoned for some considerable time.

As seen on the surface, the strike of the reef is north 60° east. The reef occurs along a faulted junction of granite and diabase, which underlies to the south at 51 degrees. The reef, which is not very thick, has been worked for some distance on the underlie. The granite foot wall shows well-marked slicken-sided faces trending in the direction of the underlie of the reef. The hanging wall of the reef is a brecciated diabase. Gold is showing in the stone.



SECTION OF THE GOLDEN RIDGE REEF G.M.L.3314.

Fig. 11.

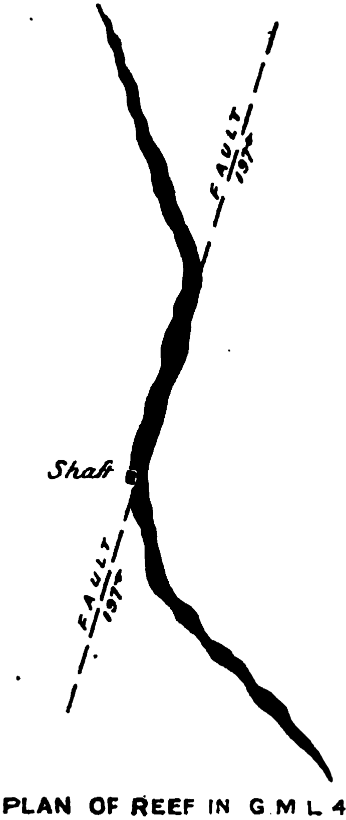
The following are the official returns from this lease:—

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	10·00	6·95	·69
1899	26·25	†166·23	6·33
1900	52·75	*69·15	1·31
1901	18·60	40·30	2·16
Total	107·60	282·63	2·62

† Includes 18·98ozs. dollied and specimens. * Includes 2·25ozs. dollied and specimens.

G.M.L. 4240.—No work was going on at the date of my visit to the property. A quartz reef enters the lease on its southern boundary at a point about 160 feet from the south-east angle of the property, on a bearing of 327 degrees. The reef has been opened up by a shaft of unknown depth. A good deal of stone has been raised, and is now lying at grass, but so far as a casual inspection went no gold could be seen in any of it.

The following is a plan of the reef:—



PLAN OF REEF IN G M L 4240

Fig. 12.

Further to the north, along the line of reef is an east and west costeen in which two reefs have been exposed. The reefs, which underlie to the westward, are about 20 feet apart, and lie parallel to the one opened up in the southern shaft.

The northernmost shaft is also inaccessible. A quartz reef, bearing 127 degrees, passes through it. This reef has an underlie of 48° to south 60° west.

G.M.L. 4241.—The greater portion of this lease lies in Lake Carey, which extends much further to the south than is shown on the existing litho. L28. Although this lease lies within the boundary of the lake it is not covered with any material thickness of alluvium, for the underlying greenstone schists crop out in the floor of the lake.

Near the north-west angle of the lease is a quartz reef bearing 263° which has been opened up by former holders of the ground. The reef, which underlies to the north, has a thickness of about two feet.

G.M.L. 4237.—Near the north-east angle of the property, which is situated on the western shores of the southern end of Lake Carey, is a quartz reef of 18 inches in thickness, with a strike of 42°, and underlying at a high angle to the north.

At a point bearing 42° from the north-east angle of the lease, and about 250 feet therefrom, the small 18-inch reef is joined by a larger one of six feet six inches, having a strike of 333°. This reef has a considerable horizontal extent, and disappears in the adjoining lease to the north. It gradually peters out northward, but its place is taken by another parallel reef, the outcrop of which lies a few feet to the east, and the strike of which is 335°. The figures below show the relation of these reefs to one another:—

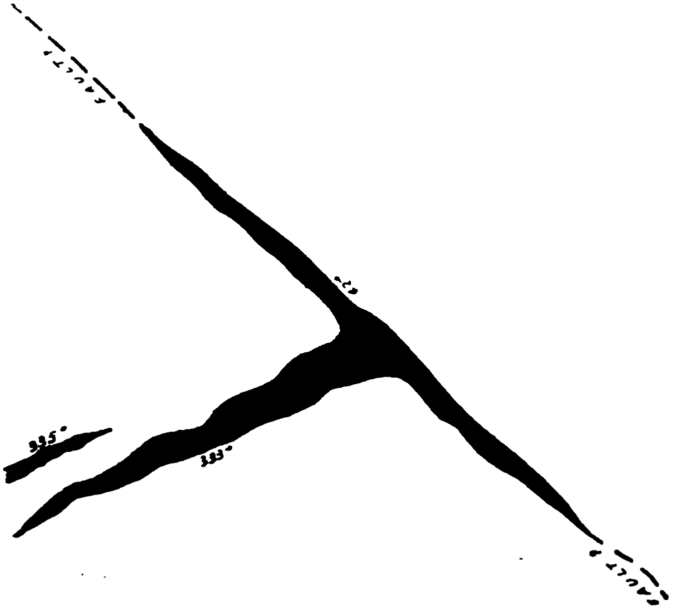


Fig. 13.—Plan of Reefs in G.M.L. 4237.

G.M.L. 4236.—The easternmost reef mentioned above as occuring in the adjoining property on the north passes through this lease and disappears beneath the surface of the lake not far from the southern boundary of G.M.L. 4235.

No work of any consequence appears to have been done on this reef.

Mt. Wilgress G.M.L. 357r.—This lease forms the centre of a group of five, trending northwards from the north-eastern corner of the proclaimed boundary of the Linden townsite.

A main shaft has been put down on the northern brow of a relatively low ridge, which trends north-west and south-east, but owing to the abandonment of the property, acccess to the workings is not possible.

A few feet west of the shaft a bluish white quartz reef, underlying to the east, outcrops, and a fairly large reef outcrops a few feet to the east. The western reef has an average strike of 131° 30′, and the eastern 148 degrees.

From the cubical cellular spaces in the western reef, it is evident that the quartz contains a reasonable proportion of pyrites at a depth; this reef, as measured on the suface, is about three feet in thickness and underlies eastward at 61°.

Returns show that in 1897 nine tons of stone from this lease were crushed for 7·50 ounces of gold, equal to ·83 ounces per ton.

G.M.L. 286.—A reef bearing 153½ degrees outcrops at some distance to the east of that last mentioned. This reef has been opened up for about a chain along its outcrop to a depth of about 20 feet. So far as could be judged from the surface, the reef has a thickness of about two feet.

GOLD YIELD OF THE LINDEN DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
Blair Athol G.M.Ls. 188r, 196r.			
	tons.	ozs.	ozs.
1899	104·00	278·80	2·68
1900	9·00	117·00	13·00
1901	. .	*11·17	...
Total	113·00	406·97	3·60
Burgess Luck G.M.L. 399r.			
1898	27·00	*520·00	19·25
1899	...	†7·83	...
Total	27·00	527·83	19·55

* Plates and extras.

* Includes 460ozs. dollied and specimens. † Dollied.

GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

CALEDONIAN G.M.L. 413R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1898	25·00	27·75	1·11
1899	48·00	23·73	·49
Total	**73·00**	**51·48**	**·70**

CRUSHED TRAGEDIAN AND TRUE BLUE G.M.Ls. 286R, 285R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1897	19·00	*41·35	2·17
1898	19·00	28·10	1·47
Total	**38·00**	**69·45**	**1·83**

* 18ozs. dollied.

FEDERAL G.M.L. 464 (LATE GOLDEN RIDGE G.M.L. 123R).

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	10·00	6·95	·69
1899	26·25	*166·23	6·33
1900	52·75	†69·15	1·31
1901	18·60	40·30	2·16
Total	**107·60**	**282·63**	**2·62**

* Includes 13·98ozs. dollied and specimens.

† Includes 2·25ozs. dollied and specimens.

GREAT CARBINE G.M.L. 406R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	36·00	42·70	1·18
1899	5·00	7·25	1·45
1900	253·00	128·25	·50
Total	**294·00**	**178·20**	**·60**

GREENHILLS G.M. Co., G.M.L. 408R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
1898	40·00	185·50	4·64
1899	1,314·00	2,689·90	2·04
1900	1,676·00	2,566·95	1·53
1901	168·00	811·75	4·83
1902	...	181·40*	...
Total	**3,198·00**	**6,435·50**	**2·01**

* From tailings by cyaniding.

GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

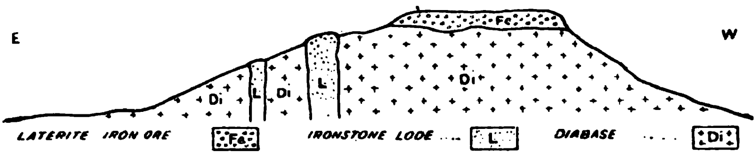
Year.	Ore crushed.	Gold therefrom.	Rate per ton.
KANGAROO G.M.L. 414R.			
	tons.	ozs.	ozs.
1898	**18·05**	**9·25**	**·51**
LADY EDITH G.M.L. 484R.			
1898	69·00	243·60	3·53
1899	105·50	451·00	4·27
Total	**174·50**	**694·60**	**3·98**
LADY ETHEL G.M.L. 387R.			
1898	252·00	293·55	1·16
1899	295·25	524·95	1·77
1900	239·00	384·40	1·60
1901	30·00	20·05	·66
Total	**816·25**	**1,222·95**	**1·49**
LAKE VIEW AND BOULDER EAST G.M. CO., G.M. LEASES 188R, 196R, 384R, 123R, 320R.			
1897	522·00	810·75	1·55
1898	61·00	34·20	·56
Total	**583·00**	**844·95**	**1·44**
MOUNTAIN MAID G.M.L. 430R.			
1898	**3·50**	**4·10**	**1·17**
MT. WILGRESS G.M.L. 357R.			
1897	**9·00**	**7·50**	**·83**
NEW YEAR'S GIFT G.M. CO., G.M.L. 407R.			
1899	164·00	112·00	·68
1900	12·00	11·00	·91
Total	**176·00**	**123·00**	**·69**
RECOVERY G.M.L. 468R.			
1899	**8·00**	**51·85**	**6·48**

GOLD YIELD OF THE LINDEN DISTRICT—*continued.*

Yield.	Ore treated.	Gold therefrom.	Rate per ton.
TRAVELLERS JOY G.M.L. 420R.			
	tons.	ozs.	ozs.
1898	37·00	46·55	1·25
1899	18·00	24·50	1·36
1900	16·00	36·00	2·25
Total	**71·00**	**107·05**	**1·50**
TRUE BLUE JACKET G.M.L. 295R.			
1897	**12·00**	**18·60**	**1·55**
WIMMERA G.M.L. 358R.			
1897	22·00	56·60	2·57
1898	85·00	136·16	1·61
1899	145·50	185·30	1·27
1900	120·00	* 179·27	1·49
1901	44·00	52·60	1·19
Total	**416·50**	**609·93**	**1·46**
PORTSEA G.M.L. 188R.			
1898	**76·00**	**51·52**	**·67**
SUNDRY CLAIMS AT LINDEN.			
1899	68·75	96·80	1·40
1900	112·75	149·40	1·32
1901	46·00	40·50	·88
1902	11·00	11·50	1·04
Total	**238·50**	**298·20**	**1·25**

* Includes 4·20ozs. dollied and specimens.

The country in the vicinity of Linde Mia (Pindinnie Soak) Reserve 5214, is all granite, of the usual type. This granite is intersected with several large quartz reefs which stand out in bold relief, and make prominent marks in the landscape, the most pronounced of these being that at the Quartz Blow Soaks Reserve 5580, distant about eight miles south-east of Linde Mia. This reef has a general strike of 115 degrees. To the west of Linde Mia, and about three miles distant, is another similar reef, which rises to an altitude of about 50 feet above the surrounding country, outcropping for a distance of about a quarter of a mile, on a bearing of 79 degrees. The quartz is pure white and destitute of mineral of any kind. Below Linde Mia and the almost deserted mining centre of Eucalyptus, granite occupies the country as far as Old Joe's Soak, Reserve 6561. A short distance to the east of the soak, and on the south side of the road, is a small hill which exposes an interesting section, shown below:



SECTION ACROSS LATERITE HILL NEAR JOE'S SOAK

FIG. 14.

The summit of the hill is formed of a thin capping of pisolitic iron ore (4639), which may possibly conceal an ironstone lode. Lower down the eastern slope of the hill are two vertical ironstone lodes (4640), about two feet in thickness in diabase. These have their outcrops partially decomposed into pisolitic iron ore, similar in character to that capping the summit of the hill. On the face of the ridge is a scree or talus of weathered iron ore, which bids fair to become in time a pisolitic iron ore also.

A little further to the east, the Eucalyptus road surmounts a low tableland of laterite, which occupies the country within a short distance of the diggings.

YUNDAMINDERA (THE GRANITES).

The auriferous reefs of Yundamindera occur along the eastern boundary of the belt of granite (4643) which extends from Lake Raeside northwards. Some portions of the granite have a rude foliation, and contain lenticular patches of what may be correctly described as micaceous schist (4644). Some of the quartz reefs, from their laminated nature, have evidently undergone a certain amount of crushing since their formation.

Very little in the way of mining was going on at the date of my visit, but the following is a brief description of such of the properties as were open to inspection:—

Landed at Last G.M.L. 443r (Potosi Co.).—The outcrop of what may be called the main reef strikes north-west and south-east, and underlies to the N. 35° E. at 32 degrees. The reef has been opened up by an underlie shaft from 130 feet to 150 feet in length, from which two levels have been driven. In No. 1 level the quartz is of a characteristic laminated type. No. 2 level, which has been driven 120 feet to the north, shows an irregular body of laminated quartz, encased in a coarse, micaceous granite of the type prevailing in the district; to the southward the level has been driven for a distance of 35 feet. At the foot of the underlie the width of the reef between the walls is five feet.

Parallel to this reef on the east, and distant about 51 feet, is another one of a similar character, which underlies at the same angle and in the same direction, but very little work appears to have been done upon it.

The official returns from this mine show that, during the years 1899 and 1900, 60 tons of quartz yielded 82·05 ounces of gold, as follows:—

Landed at Last G.M.L· 443r.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	37·00	44·05	1·19
1900	23·00	38·00	1·65
Total	60·00	82·05	1·36

Great Bonaparte G.M.L. 480r (Potosi Co.).—An east and west reef underlying to the north at an angle of 50° has been opened out at 80 and 90 feet, but no work was going on at the date of my visit. The reef is an irregular rock-bound quartz vein, enclosed in granite of the usual type. The manager of the property, Mr. Kidd, informs me that on careful sampling the stone yielded no values.

Maori Queen G.M.L. 541r.—The reef on this property is one which extends to the south-east, and traverses the two adjoining leases. The reef can be followed along the surface for over half a mile. There are three shafts on the lease. The northernmost shaft has been sunk for a distance on the underlie of a reef which is of the usual type, enclosed in granite. At the foot of the shaft drives have been put in north and south, and expose a variable thickness of quartz of the usual type. The country on both the hanging and the foot wall side of the reef has been explored by crosscuts, but nothing but granite laid bare.

The central shaft has been carried down to a vertical depth of 150 feet, but owing to the water the mine was inaccessible below the 100 feet level.

At 75 feet a level has been driven to the south-east for a distance of 100 feet, but at the face no quartz is showing. A crosscut of 10 feet in length has been put in to the north-east, and a drill-hole eight feet further in from its face, which exposed nothing but granite of the usual type. The section in this drive shows that the reef occurs along a fault fissure. Northwards from the shaft a drive has been put in for a distance of 40 feet, and a crosscut 16 feet to the south-west has intersected a quartz reef of about two feet six inches in thickness.

At 100 feet from the surface a drive has been put in 90 feet northwards, but at the date of my visit this was inaccessible, but is said to have exposed three or four inches of quartz of the usual type. To the south the level has been driven 75 feet. A crosscut 20 feet in length has been put in in an east-north-east direction, and intersected a thin quartz reef, and another a few feet further in.

This mine makes water at the rate of 3,000 gallons per diem.

The southern shaft had at the date of my visit attained a depth of 15 feet; it was contemplated continuing it until the reef met within the adjoining shaft to the north had been intersected.

The following are the yields from this lease:—

MAORI QUEEN G.M.L. 541R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	70·00	125·00	1·78
1902	290 00	582·50	2·01
Total	**360·00**	**707·50**	**1·96**

TREASURE EAST G.M.L. 493R.—The reef opened out in the Maori Queen extends throughout the whole length of the property, and a good deal of work has evidently been carried out. At the date of my visit to the mine water was standing up to No. 2 level. The mine is capable of yielding water at the rate of 150,000 gallons per diem. Along No. 2 level there is about an average of two feet of quartz exposed. Some crushings have been taken out of this mine, but owing to the fact that they are included with those from the other leases (443, 457, and 463) held by the London and Hamburg Gold Recovery Company, the exact yield of the stone from this lease cannot be given.

PRETORIA G.M.L. 511R.—There are three shafts on this property, all of them put down upon the reef opened out in the two adjoining properties on the north. There is not very much to be seen at the present time in the workings.

The most noteworthy shaft has been sunk 10 feet vertically to the reef, thence down the underlie 140 feet to the north-east, the reef showing all the way down the shaft. At the 90 feet level a drive has been put in 50 feet northerly and thence 70 feet southerly.

The central shaft on the same reef had been carried down 50 feet, through granite of the usual type. From the foot of the shaft a crosscut has been put in to the west, which, at a point 15 feet from the mouth, passed through four inches of quartz dipping to the north-east. A western crosscut exposes at 23 feet from the shaft a quartz reef of two feet in thickness, underlying to the north-east.

The most southerly shaft is inaccessible.

From the official records it appears that during the years 1901 and 1902 55 tons of quartz yielded 56·05ozs. of gold, as follows :—

PRETORIA, G.M.L. 511R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	35·00	32·85	·93
1902	20·00	23·20	1·16
Total	**55·00**	**36·05**	**1·02**

POTOSI G.M.L. 450R.—The Potosi property has been worked by an underlie shaft. The reef has been worked to within about 25 feet from the surface from No. 1 level. There being no adequate plan of the property, a full description of the workings cannot be very well given.

Number 1 level has been driven north 420 feet and south 120 feet along the reef; number 2 level has been driven north 200 feet and south 49 feet. At this point the reef is only six inches in thickness. Number three level has been carried north 165 feet along the reef, which at the face is two feet six inches in thickness. The shaft has been continued 115 feet below number 3 level, and shows four feet of quartz.

The returns for this lease are included with those of the Mount Margaret Reward Claim, Ltd.

QUEEN OF THE MAY NORTH G.M.L. 524R.—There are three abandoned shafts on the property, but all are inaccessible. So far as may be judged by the dumps, the country rocks passed through is a foliated granite of the type prevailing in the district.

QUEEN OF THE MAY G.M.L. 466R.—There are three shafts on this lease. The most northerly shaft, which is now inaccessible, has been carried down 140 feet on an eastern underlie. This shaft had been sunk upon a reef which strikes N. 35° W. The shaft is used for the purpose of supplying water to meet the requirements of the Potosi Gold Mining Company. The mine yields water at the rate of between 6,000 and 7,000 gallons per diem.

As seen in the shaft down to 100 feet level, the reef consists of a zone of sheared granite, with thin veins of quartz parallel to the planes of schistosity. At a depth of 80 feet from the mouth of the shaft a crosscut has been put in to the east for about 30 feet through a pseudo-foliated granite. At 100 feet drives have been put in to the north and south for a distance of 100 feet each way.

The central shaft has been carried down to a depth of 110 feet; at 80 feet the reef consists of a very fissile and platey quartz. The water standing in this shaft is lowered by continued pumping in the ground to the north.

The southern shaft has been carried down to a vertical depth of 60 feet through granite country, but no reef has been discovered therein.

Crushings have been recorded from this mine during the years 1899, 1900, 1901, 1902, totalling 675·6 tons, with a yield of 658·2ozs. of gold, as follows:—

QUEEN OF THE MAY G.M.L. 466R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	14·60	31·00	2·12
1900	106·00	199·75	1·88
1901	300·00	170·00	·56
1902	255·00	257·45	1·01
Total	675·60	658·20	·97

QUEEN OF THE MAY SOUTH G.M.L. 467R.—The northern shaft on the lease has been sunk to a depth of 20 feet, and a drive has been put in to the south designed to intersect the open cut just alongside the shaft. About eight or nine inches of quartz of a somewhat fissile type is showing in the drive.

The central or water shaft has been carried down 100 feet vertically; at 90 feet a drive has been extended 80 feet northwards: in it there is about an average of 15 inches of quartz showing. About five feet of potable water is standing in the shaft. The southern shaft, which has been sunk on the same reef, has been carried down to a depth of 40 feet. From the foot of the shaft a drive has been put in along the reef to the north and connects with another shaft 38 feet in depth. At about 20 feet from the northern end of the drive is about 12 inches of platey fissile quartz of the usual type. About half way up this intermediate shaft the total width of the reef and formation is from 2 feet 6 inches to 3 feet. There have been officially recorded from this mine 1,191 ozs. of gold as the result of crushing 566·55 tons of quartz, as follows:—

QUEEN OF THE MAY SOUTH G.M.L. 467R.

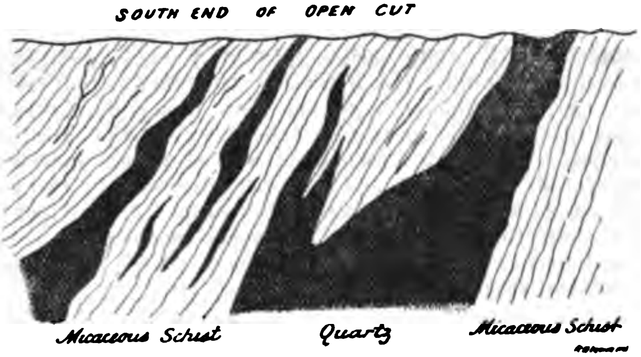
Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	16·55	33·00	1·99
1900	156·00	321·90	2·06
1901	231·00	666·00	2·87
1902	113·00	171·00	1·51
Total	566·55	1,191·90	2·10

Pindinnie Deep G.M.L. 463R.—This lease adjoins that last mentioned on the east. A vertical shaft has been put down (to an unknown depth) at the north-west angle of the lease through a micaless granite (4643). There is a little quartz of a very fissile type lying at grass; some of the quartz contained ribbons of felspar, suggesting the possibility of the quartz being merely a transmuted pegmatite vein. No work was going on at the time the lease was visited, hence a description of the workings cannot be given.

In 1900 the official records show that a crushing took place, but as it is included in the total of 125 tons yielding 157·6ozs. from the four leases 443, 457, 463, and 493, it is impossible to arrive at the exact amount of gold returned from this property.

G.M.L. 490R.—On this lease there is an underlie shaft 10 feet in depth, exposing a laminated quartz reef dipping at 41° to N. 60° E. The country rock on both the hanging and the foot walls is foliated granite of the usual type.

Little Wonder G.M.L. 522R (a new lease embracing G.M.L. 461, Woomera).—An open cut 5 feet deep at the north-west angle of the lease shows the following section :—



SECTION OF REEF IN G.M.L.522.

Fig. 15.

The quartz is enclosed in a micaceous schist, which may merely represent a transmuted granite.

At the northern end of the open cut, which is about 21 feet in length, there is only one foot of quartz exposed. The general strike of the quartz is south-east, and the underlie to the north-west at about 50 degrees. A fair quantity of quartz is lying at grass.

There are several shafts on the property and a good deal of work done, but, owing to the want of accurate plans of the workings, a definite description thereof is well nigh impossible. The reef is fairly well defined and naturally varies greatly in its size.

The returns for these two leases are as follow:—

WOOMERA G.M.L. 461R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	58·00	28·85	·49
1900	10·90	12·85	1·18
Total	68·90	41·70	·60

LITTLE WONDER G.M.L. 522R.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1901	82·00	284·00	3·46
1902	197·00	839·86	4·26
Total	279·00	1,123·86	4·02

BOER G.M.L. 508R (originally Rich View, 462R).—This is a six-acre lease adjoining the south-east boundary of that last mentioned. A great deal of work has been done on this lease by previous holders of the ground, and the reef worked practically from the surface. The reef is a rockbound vein of quartz underlying at an angle of 45° to the east, and has been intersected by two vertical shafts, one 20 feet and the other 50 feet deep. At the foot of the 50 feet shaft the reef is about 12 inches in thickness. Coarse gold and pyrites is showing in a specimen (4646) from the foot of the 50 feet shaft.

A little distance to the south another shaft upon the same reef has been put down to a depth of 25 feet, but it only exposes about an inch or two of quartz.

According to the official figures several good crushings have been recorded from the lease, as follows:—

RICHVIEW G.M.L. 462R AND BOER G.M.L. 508R.

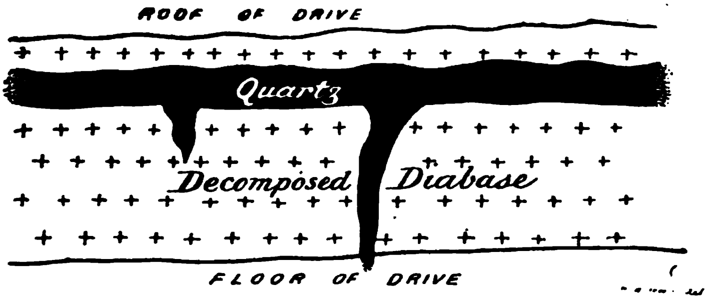
Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1900	74·00	226·80	3·06
1901	137·00	357·50	2·61
1902	62·00	207·00	3·33
Total	273·00	971·30	2·89

PENNYWEIGHT POINT.

The mining centre of Pennyweight Point lies east of Yundamindera, and due north of the trig. station (△7208) on Mt. Keith. There were only about four or five men at work at the date of my visit, hence very little could be seen. A good deal of dry-blowing must have been carried out at one period in the history of the district. The surface of the ground is covered with a shallow deposit of surface loam, beneath which is a relatively small thickness of aluminous laterite (? bauxite, 4642). The country rock seems to be diabase of the prevailing type.

The following is a description of those workings of which it was possible to make an inspection :—

Lombard G.M.L. 3349 (305R).—A vertical shaft 25 feet in depth had been put down near the northern boundary of W.R. 12 adjoining. This shaft exposes about three feet of laterite, which passes without abrupt line of demarcation into the underlying country. A drive has been put in from the bottom of the shaft for a short distance to the north-east; about 12 feet in the drive is a quartz reef underlying to the north-west at a low angle. The western side of the drive shows the following section :—



SECTION OF REEF IN G.M.L. 3349.

Fig. 16.

No work appears to have been carried out by the present occupants of the ground. The surface of the lease, however, is studded with numerous old abandoned shafts, giving silent testimony to the activity which at one time evidently prevailed.

Highland Chief G.M.L. 568R.—The Highland Chief workings are situated on the slope of a diabase hill, bearing 32° from W.R. 14R, and distant about a mile and a-half. The outcrop of the reef, which runs almost due east and west, can be followed for a considerable distance along the surface, and had apparently been opened up by previous occupants of the ground. The only accessible shaft at the date of my visit had been carried down to a vertical depth of 85 feet. At the foot was an east and west quartz reef underlying to the north at an angle of 55°. The reef had been opened out by drives put in to the east and west for a distance of

GOLD YIELD OF THE YUNDAMINDERA DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
LITTLE WONDER G.M.L. 522R.			
1901	82·00	284·00	3·46
1902	197·00	839·86	4·26
Total	**279·00**	**1,123·86**	**4·03**
LONDON AND HAMBURG GOLD RECOVERY CO.'S G.M.Ls. 443R, 457R, 463R, 493R.			
1900	125·00	157·50	1·26
1903 to 30th June ...	350·00	176·70	·50
Total	**475·00**	**334·20**	**·70**
MAORI QUEEN G.M.L. 541R.			
1901	70·00	125·00	1·78
1902	290·00	582·50	2·01
1903 to 30th June ...	20·00	28·00	1·40
Total	**380·00**	**735·50**	**1·93**
MT. MARGARET REWARD CLAIM, LTD., G.M.Ls. 450R, 456R, 536R.			
1899	76·00	170·00	2·23
1900	109·00	169·65	1·55
1901	4,718·00	3,636·54	·77
1902	2,784·00	2,580·10	·92
1903 to 30th June ...	1,243·00	853·10	·68
Total	**8,930·00**	**7,409·39**	**·83**
POTOSI NORTH EXTENDED G.M.L. 514R.			
	tons.	ozs.	ozs.
1901	116·00	173·50	1·49
1902	131·00	266·05	2·03
1903 to 30th June ...	59·00	118·00	2·00
Total	**306·00**	**557·55**	**1·82**
PRETORIA G.M.L. 511R.			
1901	35·00	32·85	·94
1902	20·00	23·20	1·16
Total	**55·00**	**56·05**	**1·02**

GOLD YIELD OF THE YUNDAMINDERA DISTRICT—*continued.*

Year.				Ore crushed.	Gold therefrom.	Rate per ton.
QUEEN OF THE MAY G.M.L. 466R.						
				tons.	ozs.	ozs.
1899	...	...	...	14·60	31·00	2·12
1900	...	...	...	106·00	199·75	[illegible]
1901	...	...	...	300·00	170·00	·57
1902	...	...	...	255·00	257·45	1·01
1903 to 30th June			...	260·00	247·00	·95
Total		...	...	935·60	905·20	·97
QUEEN OF THE MAY SOUTH G.M.L. 467R.						
1899	...	...	...	16·55	33·00	1·99
1900	...	...	...	156·00	321·90	2·06
1901	...	...	...	281·00	666·00	[illegible]
1902	...	...	...	113·00	171·00	1·51
Total		...	...	566·55	1191·90	2·10
TE ANAU G.M.L. 121R.						
1898	...	...	...	17·00	16·00	·94
TUCKER BAG G.M.L. 499R.						
1900	...	...	...	7·00	95·30*	13·61
* Includes 13ozs. dollied and specimens.						
TREASURE NORTH G.M.L. 549R.						
1902	...	...	...	72·00	127·74	[illegible]
1903 to 30th June			...	36·00	[illegible]	[illegible]
Total		...	...	108·00	[illegible]	2·16
WOOMERA G.M.L. 461R.						
1899	...	...	...	58·00	[illegible]	[illegible]
1900	...	...	...	10·90	[illegible]	[illegible]
Total		...	...	68·90	41·70	[illegible]
SUNDRY CLAIMS AT YUNDAMINDERA						
1898	..	...	...	137·00	[illegible]	[illegible]
1899	...	...	...	73·00	[illegible]	[illegible]
1900	...	...	...	39·00	[illegible]	[illegible]
1901	...	..	...	30·00	[illegible]	[illegible]
1902	...	..	...	202·00	[illegible]	[illegible]
1903 to 30th June			...	20·00	[illegible]	[illegible]
Total		...	...	501·00	884·81	[illegible]

EUCALPYTUS.

This all but deserted mining centre lies due east of Linde Mia (Pindinnie Soak).

A good deal of *bona-fide* work must have been carried out in the neighbourhood at one period of its existence; and so far as may be judged by the state of the surface a good deal of dryblowing must have been done. The productive area is embraced within the limits of about half a mile square. Practically no work was going on at the date of my visit, hence very little was to be seen. The following, however, is a description of those workings which it was possible for me to examine :—

Lady Pascoe G.M.L. 371.—An inaccessible shaft had been put down on a small quartz leader. In 1899, 10 tons from this lease yielded 4·32ozs. of gold, being at the rate of ·43ozs. per ton.

G.M.L. 315 (Shannon G.M. Co.)—An inaccessible relatively deep shaft had been put down at the south angle of the lease. On the surface at the south side of the shaft, two reefs trending respectively 298deg. and 269deg. outcrop. Very little work would seem to have been done on these. The following returns of the Shannon G.M. Co. were obtained from this lease, and M.A. 2B :—

Shannon G.M. Co.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1899	164·00	65·50	·39
1900	22·00	60·20	2·73
Total	186·00	125·70	·67

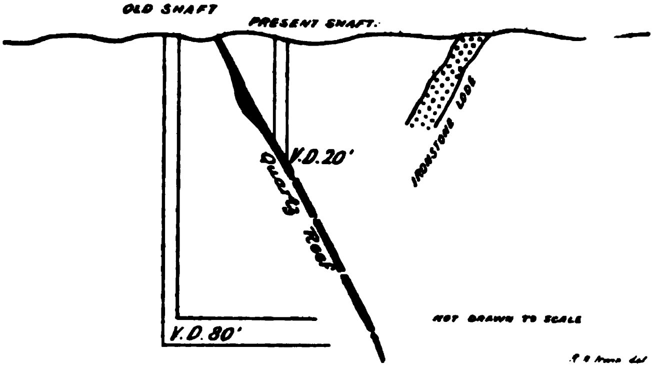
G.M.L. 398.—A water shaft had been sunk to a depth of 130 feet through diabase country, but no water was obtained.

G.M.L. 4480.—A good deal of work has been done upon the reef traversing this piece of ground. The reef first makes its appearance as a fine thread on the summit of the rising ground in the adjoining lease to the south, 367; and can be followed northwestward across the lease in the direction of 398.

Several shallow shafts have been put down at different points along the outcrop, but although some rich pockets have been met with, no serious attempt to systematically open up the reef would appear to have been made.

A vertical shaft, 80 feet in depth, had been put down by previous holders of the ground, apparently on the wrong side of the outcrop of the reef. The present holders of the ground have sunk haft 20 feet in depth. About 10 inches of quartz are exposed;

in the footwall is a rubbly ironstone leader, samples from which, in addition to showing coarse, free gold, dollied very well. The ironstone leader, I am credibly informed, has been invariably observed to cut out at from 30 to 40 feet from the surface.



SECTION OF REEF IN G.M.L. 4480

Fig. 17.

Brown Hill Reef.—A little distance south of G.M.L. 385 is what is known as the Brown Hill Reef, which trends generally north-west and south-east. This reef, so far as may be judged by the number of disused shafts, must have been extensively worked by previous holders of the ground. The reef underlies at about one in one to the west; the accessible workings show that the quartz, which nowhere is very thick, occurs along a line of fault, both the hanging and the footwall sides of the vein being strongly slickensided.

About two miles to the north is the Shannon G.M.Ls. 958 and 3372 (Triumph North) which are now abandoned. The reef, which stands boldly out from the surface, forms a prominent landmark, and has a general strike of 35deg. The quartz reef, which is vertical, and several feet thick, is seamed with veins of a siliceous oxide of iron. (4641.)

Nowhere on the surface of the area does the cover of superficial deposits exceed six or eight feet in thickness. From what may be seen in the workings, costeans, etc., it is quite evident that the diabase is intersected by a net-work of quartz veins, in reality an auriferous stock-work, to the residual decomposition of which the rich dryblown patches may be ascribed. The richness of the superficial deposits, as well as the richness of the quartz reefs and leaders, would seem to afford good grounds for somewhat more systematic mining than would hitherto seem to have been in vogue.

The drainage from Eucalyptus flows north-east into Lake Carey, along several well defined water-courses. The rich residual deposits have led to prospecting in these valleys for deep leads, but so far nothing but a thin cover of wash resting upon rock decomposin situ in the direction of kaolin, has been met with. Between Eucalyptus and the lake some miles distant, the fall is very slight, and hardly sufficient to warrant the inference that the country is likely to develop an extensive system of deep leads.

GOLD YIELD OF THE EUCALYPTUS DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
BROWN HILL G.M.L. 491R.			
	tons.	ozs.	ozs.
1900	7·00	*81·20	11·60
1901	—	†31·91	—
Total	**7·00**	**113·11**	**16·16**
* Includes 22·05ozs. dollied and specimens. † Dollied and specimens.			
CARDIGAN G.M.L. 538R.			
1900	7·00	150·00	21·43
1901	6·00	22·85	3·81
Total	**13·00**	**172·85**	**13·29**
CHESAPEAKE G.M.L. 442R.			
1899	**10·00**	**7·00**	**·70**
CORNUCOPIA G.M.L. 520R (LATE 100R NINE OF HEARTS).			
1898	520·00	718·87	1·38
1899	295·00	154·05	·52
1900	61·00	60·50	·99
1901	14·00	3·15	·22
Total	**890·00**	**936·57**	**1·05**
GOLDEN KING G.M.L. 530R.			
1900	—	*74·60	—
1901	2·00	29·85	14·92
Total	**2·00**	**104·45**	**52·22**
* Dollied and specimens.			
IRONSIDES G.M.L. 426R.			
1899	**60·00**	**25·35**	**·42**
KEEP-IT-DARK G.M.L. 416R.			
1898	**24·00**	***204·50**	**8·52**

* Includes 119·50ozs. dollied and specimens.

GOLD YIELD OF THE EUCALYPTUS DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom	Rate per ton.

KNIGHT ERRANT G.M.L. 505R.

	tons	ozs.	ozs.
1900	12·00	* 70·93	5·91

* Includes 48·60ozs. dollied and specimens.

LADY PASCOE G.M.L. 371R.

1899	10·00	4·32	·43

SCOTCHMAN G.M.L. 477R.

1899	2·35	* 110·70	47·10

* Includes 65·45ozs. dollied and specimens.

SHANNON G.M. Co. G.M.L. 315R AND M.A. 2R.

1899	164·00	65·50	·39
1900	22·00	60·20	2·73
Total	186·00	125·70	·67

UNITY G.M.L. 400R.

1898	20·00	15·00	·75
1900	3·00	6·00	2·00
Total	23·00	21·00	·91

YANDO G.M.L. 504R.

1900	4·00	* 210·20	52·55
1901	15·00	† 974·40	64·96
1902	20·00	‡ 723·61	36·18
1903	—	§ 56·16	—
Total	39·00	1,964·37	50·36

* Includes 175·10ozs. dollied and specimens. † Includes 624·75ozs. dollied and specimens. ‡ Includes 452·86ozs. dollied and specimens. § Dollied and specimens.

SUNDRY CLAIMS AT EUCALYPTUS.

1898	54·00	51·00	·94
1899	104·50	* 453·34	4·33
1900	12·00	† 115·50	9·62
Total	170·50	619·84	3·63

* Includes 332·52ozs. dollied and specimens.
† Includes 67ozs. dollied and specimens.

Leaving Yundamindera my route took me *via* French's Soak (Reserve 3387). The staple formation between the two places being granite of the usual type. About four miles to the north-east of the soak a vein of chalcedony has been opened up on the southern face of a low granite tableland. The matrix of the chalcedony is granite decomposing in the direction of kaolin. Several small veins of a chalcedonic breccia outcrop in the neighbourhood, but only upon one of them does any very great amount of prospecting appear to have been done. The vein is about six to eight inches in thickness, and has been followed down to a depth of about 10 feet. The chalcedony occurs in the form of irregular fragments along a joint or sheer plane. So far anything yet opened up is of little if any commercial value.

About a mile west of French's Soak the granite gives place to diabase (4648) which forms the summit of Mount Kildare, E52.

Between Mounts Kildare and Kilkenny, J.H.R. 19, the country appears to be all diabase. The summit of the latter peak is a fairly coarse-grained gabbro (4649, 4650).

MOUNT MALCOLM.

The Mount Malcolm neighourhood is situated in diabase and allied rocks. At the date of my visit little or no mining was going on anywhere, and with one exception access to the underground workings was not obtainable; hence no description of the reefs and other cognate points is possible. The attached map shows the position of the various reefs so far as can be seen by careful inspection of the surface, and the following table of statistics shows the gold yields of the various properties.

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
ALICIA G.M.L. 388c.			
	tons	ozs.	ozs.
1897	20·00	40·38	2·01
DEBRAH G.M.L. 406c (631T).			
1898	40·00	172·60	4·31
1899	63·00	224·90	3·57
Total	103·00	397·50	3·86
DOVER CASTLE G.M.L. 212c (4352).			
1897	40·00	49·17	1·23
1898	119·00	159·73	1·34
1899	213·00	204·76	·96
1900	63·00	23·05	·36
Total	435·00	436·71	1·00

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
DUMBARTON G.M.L. 722c.			
	tons	ozs.	ozs.
1899	25·00	37·25	1·46
1900	111·00	136·55	1·23
1901	52·00	38·07	·73
1902	30·00	18·15	·65
Total	**218·00**	**230·02**	**1·05**
FLYING PIG G.M.L. 452c.			
1897	41·07	243·22	5·92
1898	90·00	152·33	1·69
1899	62·00	189·75	3·06
1900	69·00	120·15	1·74
1901	70·00	103·85	1·48
Total	**332·07**	**809·30**	**2·43**
GOLDEN CROWN G.M.L. 756c (4519).			
1899	52·00	57·20	1·10
1900	247·00	294·95	1·19
Total	**299·00**	**352·15**	**1·17**
GOLDEN PRIZE G.M.L. 33c.			
1898	**17·00**	**21·97**	**1·29**
GOLDEN SUNSET G.M.L. 355c.			
1897	·05	1·35	27·00
1898	186·00	332·72	1·78
1899	15·00	18·00	1·20
Total	**201·05**	**352·07**	**1·75**
GREAT BARRINGTON G.M.L. 568c.			
1898	**19·00**	**8·65**	**·45**
GWALIA BACH G.M.L. 459c.			
1897	30·00	50·10	1·67
1898	10·00	9·30	·93
Total	**40·00**	**59·40**	**1·48**

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
MAFEKING G.M.L. 773c.			
	tons.	ozs.	ozs.
1900	**16·00**	**6·00**	**·37**
MALCOLM BELLE G.M.L. 576c (LATE SUNDAY, 146c).			
1897	28·00	32·93	1·17
1898	54·00	52·20	·96
1899	79·00	71·58	·90
1900	82·50	69·05	·83
Total	**243·50**	**225·76**	**·92**
MT. MALCOLM GREAT NORTHERN REEF G.M.L. 717c.			
1899	**50·00**	**23·00**	**·46**
MIDAS G.M.L., 637c (LATE MALCOLM MOHR, 147c).			
1898	373·50	262·91	·73
1899	433·00	559·26	1·29
1900	370·80	643·05	1·73
1901	303·00	276·72	·91
1902	561·00	396·08	·70
Total	**2,041·30**	**2,138·02**	**1·04**
NORTH STAR G.M.Ls. 2c, 3c, 26c (3213).			
1897	3,435·75	3,494·12	1·01
1898	1,144·00	1,197·04	1·04
1899	638·00	706·40	1·10
1900	5,076·00	4,784·15	·94
1901	2,352·00	2,248·25	·95
1902	1,233·00	2,227·07	1·80
Total	**13,878·75**	**14,657·03**	**1·05**
PRIDE OF THE NORTH G.M.L. 385c.			
1897	**5·30**	**54·00**	**10·19**
PIG AND WHISTLE G.M.L. 534c.			
1898	**36·00**	**43·10**	**1·19**

GOLD YIELD OF THE MOUNT MALCOLM DISTRICT—*continued.*

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
PRIMROSE DAY (MIDAS SOUTH G.M.L. 548C).			
	tons.	ozs.	ozs.
1898	13·00	31·55	2·42
1899	17·00	23·30	1·37
Total	**30·00**	**54·85**	**1·82**
RICHMOND G.M.LS., 12C (1196) 634C.			
1897	16·00	36·35	2·27
1898	1,079·00	1,284·26	1·19
1899	786·00	836·44	1·08
1900	48·00	29·40	·61
1901	...	*cy.* 598·54	...
1902	603·00	459·95	·76
Total	**2,514·00**	**3,244·94**	**1·29**
SOUTH STAR G.M.L. 596C (530K).			
1898	74·00	69·50	·93
1899	59·00	76·60	1·29
Total	**133·00**	**146·10**	**1·09**
SHOTOVER G.M.L. 580C.			
1899	**10·00**	**5·10**	**·51**
WHISPERING HOPE G.M.L. 617C.			
1898	21·00	16·92	·80
1899	53·00	44·28	·83
Total	**74·00**	**61·20**	**·82**
KNARK G.M.L. 946C (770C).			
1902	**27·00**	**10·18**	**·37**
SUNDRY CLAIMS AT MOUNT MALCOLM.			
1898	44·00	61·99	1·40
1899	6·00	12·71	2·12
1900	111·50	81·65	·73
1901	32·00	20·00	·62
1902	429·00	475·21	1·10
Total	**622·50**	**651·56**	**1·04**

SUMMARY.

One of the most noteworthy features in the country under examination is the occurrence of a continuous belt of iron-bearing cherts or quartzites, which has been followed for a distance of not less than fifty miles. There are strong reasons for believing that it extends northwards as far as Mount Morgans. The beds of which the belt is composed range from an almost pure quartz, through banded jaspers, often of great beauty, to what appears to the eye to be practically pure hematite. Analyses of the typical varieties of the different classes of ore showed that, contrary to their general appearance, they all contain a high percentage of silica, and a relatively low percentage of iron. Many of the deposits could readily be concentrated to high grade ores. Although the geographical position of the deposits puts them, under present conditions, beyond the reach of commercial enterprise, there is little doubt that were they more favourably situated as regards proximity to fuel, fluxes, or even water carriage, some of them might be turned to profitable account. Of the origin of the deposits it is difficult, with our present knowledge, to form any precise opinion. They are evidently not of clastic origin, occurring as they invariably do, in the greenstone schists; these have invariably been subject to a great amount of bleaching and decomposition in close proximity to the deposits. The greenstone schists contain a certain proportion of iron compounds in their composition, and the bleaching action in proximity to the quartzites would seem to imply that these form the source of the iron ore, and possibly that of the silica with which these ores are invariably associated. The iron-bearing quartzites occur in the form of attenuated overlapping lenses along what are evidently sheer planes of remarkable persistence, which, by virtue of their lamination, have formed channels for the more or less free circulation of mineral-bearing solutions.

On either side of the hematite-bearing belt numerous quartz reefs outcrop, and several mining centres—Yarri, Edjudina, Linden, Eucalyptus, etc.,—have been opened up, and so far as may be judged by the official statistics, a considerable quantity of gold has been won, though it is doubtful if all the gold actually obtained has been officially reported. In view of the extent of what may be termed the Edjudina-Yundamindera mineral belt, and the number of reefs actually outcropping in addition to those actually worked, there seem to me to be sufficient ground to warrant rather more vigorous prospecting than would hitherto have apparently been the case.

By Authority Wm. Alfred Watson, Government Printer, Perth.

ERRATA AND ADDENDA.

NOTE.—*The pagination is counted as one line.*

Page 6, line 46, *add*—

> Owing to exigencies of the public service, necessitating my presence in another portion of the State, it has not been found possible to devote any time to detailed petrographical descriptions of the various rocks embraced by this report. A great many sections have been cut with the view to microscopical examination, which it is hoped will be undertaken as opportunity offers.

Page 10, line 14, *for* "costeen" *read* "costean."

Page 10, line 15, *for* "costeen" *read* "costean."

Page 15, line 40, *for* "Bessemerprocess" *read* "Bessemer process."

Page 28, line 31, *for* "sheer" *read* "shear."

Page 58, line 30, *for* "sheer" *read* "shear."

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1904.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 12.

THE GEOLOGICAL FEATURES AND MINERAL RESOURCES
OF
MULLINE, ULARRING, MULWARRIE,
AND
DAVYHURST,
NORTH COOLGARDIE GOLDFIELD,

BY

CHAS. G. GIBSON, B.E.,
ASSISTANT GEOLOGIST.

WITH TWO MAPS.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

PERTH:
BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.
1904.

PREFATORY NOTE.

THE examination of Mulline, Ularring, Mulwarrie, and Davyhurst was primarily undertaken with the object of showing the mutual relationship of the Auriferous Series at these different localities. The results of this investigation are shown on the maps, prepared by Mr. Gibson, which are correct so far as the scale of the field plans employed would permit. The ground embraced by the work covers an area of about 174 square miles, and includes all the important mining centres.

The staple formation of the district, apart from the extensive cover of the ubiquitous superficial deposits, is made up of a complex of hornblende rocks (" Greenstone "), which form the auriferous series, conforming in this respect to the other fields so far examined. The series form a belt of ten or more miles in width, and probably some 150 miles in length. There seem to be good grounds for believing that this forms part of the belt which includes Coolgardie, 90 miles to the south, and Mount Ida, 54 miles to the north; thus proving a known auriferous belt of 144 miles in length, along which it would not be unreasonable to anticipate the occurrence of other deposits quite as rich as any of those already opened up.

The hornblende rocks are intersected by biotite-granite, from which dykes attaining a thickness of 30 or 40 feet emanate. Some of these have been followed across country for several miles, and in one instance a dyke has been worked for its gold contents.

The quartz reefs, though with one or two exceptions small (and when worked below water level contain large quantities of sulphides), seem on the whole to be well defined, and give every promise of being permanent.

The report is accompanied by schedules of gold returns, compiled from the latest official statistics, which demonstrate that, from the area embraced by Mr. Gibson's work, there have been raised, up to the end of 1902, 73,625·33ozs. of gold from the crushing of 44,788·91 tons of quartz, thus giving an average of over one and a-half ounces of gold to the ton.

With the advent of systematic scientific mining, together with the erection of suitable machinery, there seems every reason to believe that the district will show a marked increase in its gold output in the future.

So far as the origin of the gold is concerned, it is quite clear that in the Ularring District the deposition of the gold took place after the intrusion of the granite, at whatever geological period that occurred.

The district is, as a whole, well-timbered, though not particularly well watered; this condition of affairs might be overcome by either surface conservation or well-sinking.

The report and explanatory maps, being submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Beaufort Street, 20th January, 1904.

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MAPS.

I. Geological Sketch Map of Mulline, North Coolgardie Goldfield. Scale, 40 chains per inch.

II. Geological Sketch Map of Mulwarrie and Davyhurst, North Coolgardie Goldfield. Scale, 40 chains per inch.

The Geological Features and Mineral Resources

OF

MULLINE, ULARRING, MULWARRIE, & DAVYHURST.

Boundaries of the Field.—The North Coolgardie Goldfield was proclaimed on 29th May, 1895. It had its boundaries altered on 12th March, 1897, and at present embraces an area of 30,609 square miles, which, according to authorities, is bounded:—

> "By lines starting from the southernmost corner of the Murchison Goldfield, being the south-west corner of the East Murchison Goldfield, and situate about twelve miles east and five miles south from trig. station K.75 on Wyemando Hill, and extending south to the south-east corner of the Yalgoo Goldfield, which is a point due east from Mount Gibson, near Lake Moore, and due north of a spot ten miles west of a cairn on Yorkrakine Granite Rock; thence east-south-east to a point about fifty miles due west from a cairn marked N.B.1, near Wangine Soak; thence east to survey station N.B.1; thence about 87° twenty miles twenty-two chains to survey station R.3; thence east to the 125th meridian east longitude; thence north along that meridian to a point east of a tree marked B.82 at Brickey's Soak; thence west through the said tree to a spot about 76¼ miles west from it, and thirteen miles north and fifteen miles east from the summit of Mount Ida; thence north about thirty-one miles to the south boundary of the East Murchison Goldfield, and west to the starting point."

This field, which originally formed part of Coolgardie, and from which it was divided owing to the discovery of many rich reefs around Menzies, and the rapid increase of population, has, for purposes of administration, been subdivided into the Menzies, Ularring, Niagara, and Yerilla districts.

History of the Field.—Nothing official has been recorded of the history of the North Coolgardie Goldfield.

Previous Observations on the Geology of the Field.—Beyond a short report by Mr. Woodward * on the Mount Ida district, nothing official has been written about the geology of the field.

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* Annual Progress Report of the Geological Survey, p. 12, 1901. By Authority: Wm. Alfred Watson, Government Printer, Perth.

The Extent of the Map.—The area which has been mapped and depicted on the plan embraces an area of about 174 square miles, and includes the mining centres of Riverina, Mulline, Ularring, Mulwarrie, and Davyhurst. The map makes no pretensions to absolute accuracy, except in the near vicinity of the mining leases, the nature of the country, and the absence of any distinctive hills or landmarks rendering accurate work almost impossible at any distance from the lease pegs, that is, with the means—compass and plane table—and time at my disposal.

General Description of the Country.—The country generally consists of level plains covered with a considerable thickness of recent superficial deposits, through which rise low rough greenstone hills and ridges, and bare outcrops of intrusive granite. These greenstone ridges are especially numerous in the Riverina district, where they rise to a height of about a hundred feet, trending northwards beyond the limits of the map and then away slightly west of south past Mulline and Ularring to a point some four miles south-south-west of the latter place, where they die out below the alluvium of the plains, re-appearing again about a mile north of Mulwarrie and running south through this place and on towards Callion beyond the southern boundary of the map. Eastward from Mulwarrie towards Davyhurst the country is uniformly flat, the greenstones outcropping here and there, but being for the most part covered with superficial deposits varying in thickness from a few inches to many feet. The hills and ridges are often covered with a capping of considerable area of ironstone gravel.

Intruded into the greenstones in several places are large masses of granite. These occasionally outcrop as low bare hills, of which the Ularring Rocks are a typical example, but more often are found to be covered to a considerable depth with loose sandy soil resulting from their own weathering.

The greenstones are bounded on the west by a belt of intrusive granite, which rises as a low north and south ridge of hills some six or eight miles west of Mulline. Intermediate between these hills and the greenstone ridges of Mulline and Ularring is a considerable extent of sandy flats, which, from their general appearance, are probably overlying granite, and which are thickly covered with spinifex and stunted mulga.

Numerous dykes of acid eruptive rocks are found intersecting the greenstones in all directions, especially in the neighbourhood of Mulwarrie, where, however, their prevailing strike is north-west and south-east, and where they can be followed across country for some miles.

The belt of greenstones, which forms the auriferous series has eneral north and south trend, and is at the least some eight or iles in width, and is probably the same belt in which the ous deposits of Coolgardie and Mt. Ida are situated.

Recent Superficial Deposits.—These are of two kinds: (*a.*) The loose incoherent material which is found covering the greater portion of the district, and (*b.*), the nodular ironstone gravels. Of these, the former is of very considerable extent, covering the flats and low-lying country to a depth of from a few inches to 50 or 60 feet; it is the result of the gradual weathering of the older granite and hornblende rocks, and where found overlying the former is much lighter in colour, looser, and more sandy, and is generally covered with spinifex and stunted mulga. The nodular ironstone gravels, or laterite deposits, usually occur as the cappings of hills and ridges, and are of much more limited extent. Deposits of this kind are found throughout the State, and have been thus described by Mr. Simpson* in Bulletin VI. of the Geological Survey:—

> " These, with the gravels resulting from their denudation, are the most widely distributed iron ores in the State, but are unfortunately the most erratic in quality, varying from a ferruginous bauxite or claystone to an almost pure limonite or turgite. The structure is sometimes massive and almost homogeneous, but it is more frequently pisolitic or nodular, in which cases the concretions are richer than the interstitial matter. Occasionally the ore is cellular and streaky in colour whilst still more rarely it appears brecciated, the angular fragments then consisting of almost pure hematite or limonite. They are invariably found as superficial deposits overlying granite, diorite, or amphibolite, or chlorite schists derived from them. They are most largely developed on the caps of the hills or ranges but in many cases follow down the sides of the hills parallel to the undulations of the bed rock, from which they are not separated by any hard and fast line. In depth they pass gradually into such highly ferruginous rocks as the diorites of the Darling Range, or the amphibolites and chlorite schists of the interior. At Kalgoorlie, cappings of very rich laterite occur on some of the hills underlaid by clays now poor in iron, from which the iron was originally derived, for it represents the result of decomposition *in situ* of highly ferruginous amphibolite. At Darlington and elsewhere they are found to overlie granite as well as diorite or other basic rocks, but never far from the latter. They can, in every case, probably be accounted for by the concentration of the ferric oxide resulting from the surface decomposition of rocks rich in iron."

Hornblende Rocks (Greenstones.)—These rocks, which comprise the auriferous series, and to which the general term "Greenstone" has been applied, consist principally of a very fine grained diorite, passing in places into a coarse-grained variety, as well as an indefinite somewhat foliated rock, which is probably only an altered form of the former, and are for the most part very decomposed and weathered to a depth of from 150 to 180 feet. In the neighbourhood of the Riverina leases these rocks outcrop as rough ridges, and are but very little decomposed; they are massive with no signs of foliation, and are of both the fine and coarse-grained varieties; between these there is no hard and fast boundary, and they are evidently merely different forms of the same rock. South from the Riverina, past Mulline and Ularring, they are all of one class, consisting of a fine-grained, massive diorite. At Mulwarrie and its vicinity they are again of the two varieties, the fine-grained predominating however. There are also one or two small areas in this locality over which the rocks are somewhat foliated, the foliation running parallel to, and being apparently due to the presence of, numerous granite and felsite dykes, which run through the greenstones here in a general north-west and south-east direction.

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* Geological Survey of W.A. Bulletin No. 6, page 36, 1902. By Authority: Wm. Alfred Watson, Government Printer.

At Davyhurst again they are entirely of the fine-grained variety, but are considerably more foliated here than in any other part of the district. At one spot, about three-quarters of a mile west of Davyhurst township, they have been altered for a width of about two chains, probably by pressure due to faulting, into highly inclined actinolite schists. This belt of schists runs on a bearing slightly west of north and east of south, and can be followed across country for some distance, gradually passing on either side into unaltered fine-grained diorite.

Sections of each of these varieties of diorite show them, when examined under the microscope, to consist essentially of pale-green hornblende and triclinic felspar, with magnetite in small grains scattered through the section, the hornblende and the felspar being present in about the ratio of 3 to 2; the only difference between the two rocks being in the size of their component crystals.

This belt of greenstones is at the least more than eight miles across, and is probably the same belt in which the auriferous deposits of Coolgardie and Mount Ida are situated.

The junction of the greenstones and the granite is for the most part hidden by the superficial deposits, but where it can be seen the greenstones are found to be highly foliated and contorted, the lines of foliation being parallel to and dipping away from the line of the granite; small patches of foliated greenstone are often found caught up in the granite.

Granite.—Bounding the greenstones on the western side, and intruded into them in several places within the district mapped, occurs massive granite. This is of a fairly coarse-grained biotite variety, hornblende being, as far as could be seen by microscopic examination, almost entirely absent. It outcrops only in isolated cases, usually as low bare hills, being for the most part covered with its denuded remains, principally sand. A section cut from a specimen taken from the Ularring Rocks at trigonometrical station N.B. 9, and seen under the microscope, shows it to consist of:—

(*a.*) Quartz.—Abundant in large irregular lumps and grains, and containing numerous inclusions.

(*b.*) Felspar.—Very abundant, occurring as large irregular grains and imperfectly formed crystals; it is principally of the monoclinic variety, though a little plagioclase is present as well as a fair amount of microcline.

(*c.*) Biotite: Present in brown tabular crystals, but not very abundant.

(*d.*) Hornblende: Present in small dark green crystals, but only in very small quantity.

The rock is somewhat decomposed.

Acid Eruptive Dykes.—Intersecting the greenstones in many places are eruptive dykes of acid rocks; these vary in size from a few inches to 30 and 40 feet, and run in all directions; the more general strike of them, however, being about north-west and south-east. They are especially numerous in the neighbourhood of Mulwarrie, where they can be traced through the greenstones on a general north-west and south-east bearing for several miles. They are closely allied to and are probably connected with the main intrusive masses of granite. Microscopic examination shows them passing through all gradations, from a very coarse granite to exceedingly fine-grained compact felsites and quartzites. These dykes are more recent than the quartz reefs of the district, and are found in several instances cutting right through the latter, and as a rule without having any effect on their strike, dip, or gold contents. In one instance—at the Thunderbolt G.M., Mulwarrie—one of these felsite dykes itself is being mined; this is partly due to the presence of small quartz stringers running through the rock, forming a class of stockwork, and also to the presence of a fairly large body of quartz running alongside the dyke. Only the quartz and the stockwork are being worked, the dyke rock itself, when free from quartz, carrying no, or at most only a trace of, gold.

REEFS AND LODES.

Lodes.—Only a few instances of auriferous lodes are met with in the district, and as such they occur in intimate connection with the quartz reefs, and are usually found associated with numerous quartz stringers and veins and occasionally with large bodies of quartz; in some cases it being difficult to say whether they should be classed as lode formations or as quartz reefs. In appearance they differ only from the country rock in that they are usually more highly foliated and much softer, and generally traversed by small quartz veins. They have no defined walls, their boundaries, both horizontally and vertically, being determined solely by the decrease in the assay value of the stone. Speaking of the lode formations of Western Australia,* Mr. Simpson, in Bulletin 6 of the Geological Survey, says:—"A 'lode formation' may be defined as a more or less vertical zone of rock, usually continuous with the surrounding rocks, and of similar origin, but distinct from it in carrying metallic ores disseminated through it in payable quantities, and, as a rule, characterised by strong foliation. Deposits of this nature are probably deep-seated; at Kalgoorlie, mining operations have already proved their persistence to 1500 feet below the surface. The typical lode formations probably owe their origin to a shearing action having crushed and foliated portion of the rock mass in a certain definite direction, producing a more or less well-defined band of rock through which, by virtue of the foliation, mineral bearing solutions or vapours can have free circulation. In consequence of this, mineral deposits are formed within the rock, usually, but not necessarily, extending over the whole of the foliated zone, but seldom beyond it, and having no definite boundaries, horizontally or vertically, other than those determined by the decrease of the assay value of the rock in any one direction to a point at which it ceases to pay the expenses of working."

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*Geological Survey, W.A., Bulletin 6, p. 22. By Authority: Wm. Alfred Watson. Government Printer, 1902.

Quartz Reefs.—These are found to vary considerably both in size and in the direction of their strike. The prevailing trend, however, is slightly west of north and east of south, though reefs with an almost due east and west strike are being profitably worked at the Mulline and Cooladdie mines, Mulline; the east and west reefs, however, are generally smaller and more irregular than the north and south ones. On the whole all the reefs in the district may be said, with one or two exceptions, to be small; they are, however, generally speaking, regular and very well defined, and give every promise of living to a considerable depth. Wherever worked below water level they have been found to be highly charged with sulphides; this also very often happens long before water level is reached, for example, the Lady Florence G.M., Mulline, and the Homeward Bound G.M., Mulwarrie. The gold both in the reefs and lodes is generally found to occur in chutes, the length of these chutes being, roughly speaking, from 150 to 300 feet.

Water.—The district as a whole is not particularly well watered. A good supply of fresh water can, however, usually be obtained during the winter months from the soaks at the Mulline, Cooladdie, and Ularring Rocks; this supply, however, depends on the rainfall, and generally gives out before the end of the summer. Fresh water has also been struck in two or three of the mines, viz., the Riverina mine at 160 feet, the Redleap mine, Ularring, at 135 feet, and the Mulwarrie mine, Mulwarrie, at about 160 feet. Water fit for stock purposes has been also met with in the Mulwarrie Main Reef mine, Mulwarrie, at a depth of about 120 feet. Generally speaking, however, the water supply of the district is salt, and, being unfit for domestic purposes, necessitates the use of extensive condensing plants. So far the supply in the mines is not known, as the majority of them have not carried their workings below water level, and no pumping is being done.

The following are the depths and the daily supplies from the Government wells in the district:—

Mulline State battery well, depth 130 feet, 13,000 gallons, carrying 1·13 per cent. of solids.

Mulwarrie State battery well, depth 160 feet, 4,000 gallons, carrying about 5 per cent. of solids.

Mulwarrie Government well, depth 158 feet, 4,080 gallons, carrying 2 per cent. of solids.

Davyhurst Government well, depth 137 feet, 1,200 gallons, carrying 2 per cent. of solids.

The water in each of these wells is salt, but at both State batteries it is suitable for, and is being used for, both milling and cyaniding purposes.

Timber.—The district as a whole is well timbered, such being especially the case in the vicinity of Mulwarrie and Davyhurst, where the low-lying flats are covered with a heavy growth of mulga, gimlet, and white gum.

THE MINES.

The following is a brief description of the principal mines working in the district at the time of my visit, June, 1903:—

Mulline District.

Riverina G.M.L., 123u.—There are a number of shafts on this property working on a fair-sized north and south quartz reef, which runs through the lease near its western boundary; the deepest of these is down about 160 feet. A main winding shaft has been sunk vertically to a depth of 200 feet about two chains to the east of the reef, and crosscuts put in to cut the reef at 100 and 200 feet. Levels have been driven along the reef at 80, 160, and 200 feet; that at 200 feet has been put in some 40 feet north and the same distance south from the main crosscut; no stoping has been done at this level; at 160 feet the drives extend 130 feet south and 50 feet north, whilst at 80 feet the total length of driving is about 300 feet, and for the whole of this length the reef has been stoped out to the surface. A short intermediate level has been put in at 120 feet, and a small amount of stoping done.

The reef consists of white quartz with varying thicknesses of schistose formation between it and the walls; this formation, as a rule, only carries a very small quantity of gold. The stone varies in size from one to three feet, the quartz being found at one time on the hanging-wall and at another on the foot-wall; the walls are clean and very sharply defined and run absolutely vertically, the distance between them averaging about four feet. The chute of gold at present being worked dips to the south at a steep angle. The country is soft down to about 160 feet, where it becomes very hard and settled; at this point sulphides begin to come in, and are fairly abundant at water level.

Fresh water was struck at about 165 feet.

Two other lines of reef run through this property; one is a short north-east and south-west reef, which outcrops near the centre of the lease. This, as far as tested, has proved to be entirely destitute of gold. The other is a north and south reef, which runs into the lease from the south near its western boundary. The only work done on this reef on this property consists of a shaft sunk to a depth of about 30 feet. The reef is about two feet wide, and is expected to average about 15dwts. The main line of reef has been proved through the entire length of the lease, and also for a considerable distance into the adjoining property on the north, where it has been worked to a depth of about 130 feet. Near the southern boundary of the Riverina it is cut off by an east and west fault, and thrown about 60 feet to the eastward. From this point southward its course is not so regular, it gradually turning away easterly as it runs through the adjoining lease (the Riverina South).

This property has crushed, up to the end of 1902, 5954·00 tons for 4,068·59ozs., giving an average of ·68ozs. per ton, the gold being worth £3 12s. 6d. per ounce.

Riverina South G.M.Ls. 324u, 600u.—The main line of reef at present being worked on this property is a continuation of the Riverina reef; as above stated, its course through this property is not so regular, the reef having a gradual trend away to the eastward. It has been worked to a vertical depth of about 130 feet on this property, and a considerable amount of stone taken out.

A second quartz reef is at present being prospected near the eastern boundary of the lease; this is a small reef running north and south, on which a shaft has been sunk to a depth of about 50 feet.

The stone crushed from these leases to the end of 1902 is 2,523·00 tons for 2,204·38ozs., being at the rate of ·87ozs. per ton.

Mulline G.M.L. 2u.—On this property a small quartz reef is being worked; the reef runs east and west, and dips at an angle of about 12° to the north; it varies considerably in size, ranging from a mere thread to as much as two or three feet; its average width is about 12 inches; the dip also varies a good deal.

A little to the east of the main line of shafts the reef is cut off by a fault which runs slightly to the east of north, and dips at a fairly steep angle to the westward; no extension of the reef has so far been found beyond this fault. Several north and south faults cross the reef farther west, it in each case being thrown downward for a few feet, and also slightly to the west.

The country is soft decomposed greenstone.

A large quartzite dyke runs north and south through the lease some 50 feet to the west of the main line of shafts cutting through the reef, without, however, displacing it at all. Several ts have been sunk to cut the reef, the most northerly or main hauling shaft being down 90 feet vertically, thus being the deepest vertical shaft in the property. The reef itself has been followed on the underlay for a distance of slightly over 600 feet from the surface. At 300 feet, levels have been put in east and west for 40 feet each way, and stoping carried up to the surface for this length. Practically no driving or stoping has been done below this level.

A second small east and west reef outcrops close to the southern boundary of the lease; a good deal of work appears to have been done on it, but it is now abandoned.

The whole neighbourhood is full of small quartz reefs, all carrying gold, but not of sufficient size to pay for working.

Total stone crushed to the end of 1902 is 899·25 tons for 1,384·85ozs., being at the rate of 1·54ozs. per ton, the gold being worth £3 13s. 6d. per ounce.

Cooladdie G.M.Ls. 333u, 408u.—The reef being worked on this lease is also an east and west one, with a very flat dip of 9° to the south. The lode consists of a quartz reef averaging about 12 inches in width, together with about two feet of schistose formation, which, as a rule, only carries a slight trace of gold, and is generally discarded. The quartz is found sometimes on the hanging-wall and sometimes on the foot-wall, and varies in size from 9 to 18 inches. The length of the chute of gold at present being worked is about 200 feet.

Several shafts have been sunk to cut the reef, the deepest being a little over 100 feet vertical. An underlay shaft has also been sunk on it for a distance of nearly 700 feet from the surface. At 600 feet, a level has been put in east for a distance of 50 feet, and the reef stoped out for this length up to 250 feet, and from this level to the surface for a distance of 150 feet east and 60 feet west.

The country is fine-grained greenstone, very soft and decomposed in the upper levels, but getting harder towards the bottom workings. No water has been met with, so far.

This mine has crushed, up to the end of 1902, 2,073·50 tons for 3,197·36ozs., giving an average of 1·54ozs. per ton, the gold being worth £3 12s. 6d. per ounce.

Lady Florence G.M.L. 403u.—Two large quartz reefs run through this property in a north-west and south-east direction. On the most western of these three shafts have been sunk, two of which are now in use; of these, the deepest is down 120 feet, of which 80 are vertical, 20 underlay, and 20 vertical again, whilst the other is down 100 feet, 50 vertical and 50 underlay. Levels have been driven along the reef for about 100 feet at the 100 feet level and a little stoping done, while a good deal of driving and stoping has been done between this and the surface. The reef consists of white quartz averaging four feet in width, and has clean, sharp greenstone walls. The stone is very heavily mineralised from 100 feet down.

The second reef is about three chains farther east, and runs approximately parallel. Several shafts have been sunk on it, but only to a depth of about 40 feet, and practically no work has been done on it. The reef, where cut at 40 feet, is about 12 feet in width, and dips slightly to the east; the quartz is white, considerably broken, and ironstained.

This property has crushed, to the end of 1902, 631·25 tons of stone for a yield of 463·98ozs. of gold, being at the rate of ·73oz. per ton.

LADY GLADYS G.M.Ls. 139U, 235U, 555U.—The original workings on this property were situated on a mass of highly decomposed greenstone immediately underlying a capping of ironstone gravel; a little quartz is disseminated throughout the mass in fine veins and stringers, and the whole over an area of about half an acre was highly auriferous. This was worked out down to a depth of about 30 feet when the gold suddenly gave out. At this point a small, very flat quartz reef was picked up. This reef was here about six inches in width, and dipped west at an angle of about 15 degrees. At the spot where first picked up it seemed to have been cut off to the north by an east and west fault as no continuation of it was found to the northward. The gold in the decomposed greenstone probably owed its existence to the presence of this reef, which was here exceptionally rich. The reef continues on its westerly dip of 15 degrees for about 40 feet, when the dip suddenly changes to about 35 degrees for 15 or 20 feet, and then back again to the original 15 degrees. In the lower workings the dip of the western reef gradually changes, and in the bottom level is about south-west instead of west. Just about the main line of shafts the reef takes another sudden change, and dips away steeply to the eastward. This eastern arm is somewhat smaller than the western, and as far as tested is practically free from gold. The size of the western arm varies from about 12 inches in the upper levels to about 2½ feet at the bottom levels. It has been worked out on the underlay to a vertical depth of about 150 feet. Several shafts have been sunk along the line of the cap of the reef, whose general trend is about north-west and south-east, and these have been connected by a main drive and the reef stoped out for a width of about 70 feet west of the line of shafts. The quartz is very heavily charged with pyrites below 110 feet, at which point the country begins to get very hard and compact.

The adjoining leases on the east are working small north and south quartz leaders. These dip to the east and are very rich in places.

Total stone crushed to end of 1902 is 5,915·00 tons for 14,347·71ozs., including 186·73ozs. dollied and specimens, giving an average of 2·42ozs. per ton, the gold being valued at £3 17s. 7d. per ounce.

Shamrock G.M.L. 1u.—A small quartz reef runs through this lease, near its western boundary, on an almost due north and south bearing. Several shafts, all underlay, have been sunk on it, the deepest to a depth of 130 feet, and a good deal of work has been done. The reef is about 18 inches in width, and dips at an angle of about 60 degrees to the east. It has been stoped out from 130 feet to the surface for a distance of about 200 feet; from the surface down to 40 feet the gold contents were rather poor, but from this point down they averaged from 30 to 40dwts. The chute of gold is about 200 feet in length, and dips to the south. The country is fine-grained greenstone, and on the foot-wall at 130 feet is fairly hard and settled; on the hanging-wall it is much softer and more broken. No water has been met with, so far.

This mine has crushed, to the end of 1902, 1,009·25 tons for 1,623·08 ozs., giving an average of 1·61 oz. per ton.

Table showing Gold Returns from Leases in the Mulline District, other than those already mentioned, up to the end of 1902.

Name of Lease.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Acrobat	327u	55·67	85·50	1·53
Ajax	501u	257·75	296·85	1·15
Albury	74u	25·00	66·90	2·67
Anastasia	552u (243u)	20·00	9·90	·49
Argentina	450u (357u)	148·00	67·80	·46
Belle Mai	179u	925·00	1143·57	1·23
Boer	446u	11·00	5·00	·45
British Lion	162u	68·30	78·75	1·15
Chamberlain	330u	107·00	118·40	1·10
Cocas	433u	34·50	46·50	1·34
Comet	601u	72·00	63·80	·89
Cora	553u	36·25	136·54	3·77
Chiltern	448u	34·50	19·05	·55
Dawn	362u	30·00	19·50	·65
Day Dream	206u	10·00	2·10	·21
Day Dream South No. 2 Extended	314u	81·00	94·75	1·17
Dismissal	688u	22·00	13·64	·62
Don Juan	353u	72·50	76·30	1·05
Duchess of York	603u	134·00	79·07	·59
Dungan	340u	156·50	101·40	·64
Exchange	542u	7·00	11·75	1·67
Golden Lode	350u	13·50	23·60	1·74
Gold Standard	435u (315u)	248·00	255·32	1·03
Great Expectation	483u (385u)	55·00	9·90	·18
Hornet's Nest	635u	3·50	7·70	2·20
Karrakatta	575u	12·00	89·50*	7·46
Lady Gladys Junction	670u (290u)	902·00	852·48	·94
Le Grand	584u	7·00	6·60	·94
Marvellous West	328u	158·00	159·85	1·01
Monarch G.M. Co.	451u (95u)	390·00	373·19	·96
Mikado	528u	19·00	21·25	1·11
Mulline Commonwealth	704u (206u)	51·00	27·61	·54
Mulline Rose	595u	31·50	18·08	·57

* Includes 12·05ozs. dollied and specimens.

Table showing Gold Returns from Leases in the Mulline District, etc.—continued.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Mulline Surprise	710U	17·50	22·23	1·27
Mystery	548U (437U)	137·00	141·35	1·03
New Find	409U	25·00	198·70	7·94
Nil Desperandum	434U (328)	646·75	889·76	1·37
Our Luck	311U	50·00	59·75	1·19
Queen Mary	583U	45·50	14·02	·31
Refuse	423U	58·00	50·05	·86
Reprieve Leases	422U, 462U	727·50	1718·25	2·36
Riverina Preseverance	545U	69·00	61·87	·89
Rose and Shamrock	357U	121·00	66·85	·55
Schnider	497U	18·00	14·15	·78
Three Gins	705 (390)	12·50	33·78	2·70
Try Again	367U	200·75	195·17	·97
Victoria	571U	62·00	97·14	1·56
Vera	385U	20·50	30·58	1·49
Waratah	661U	7·00	3·35	·48
Yankee Doodle	708U (345U)	29·00	13·65	·47
Young Australian	699U (332U)	170·00	373·17	2·19
Young Australian East	703U (332U)	7·50	3·04	·40
Sundry Claims	...	570·00	840·92	1·47

Ularring District.

Redleap G.M.Ls. 89U, 92U (London and Coolgardie Explorers, Limited).—There are five shafts on this property sunk on a quartz reef running north-west and south-east. These shafts are all underlay, and are from 130 to 165 feet in depth; the most southerly is the deepest, and has been sunk on the underlay 165 feet to water. From this shaft levels have been put in at 100 and 130 feet, but very little work has been done at this latter level. At the 100 feet a drive has been put in along the reef 150 feet south and 50 feet north, and the reef stoped out to the surface for a length of about 150 feet. This shaft is at present abandoned. The north shaft has been sunk 135 feet, at which point water was struck; at 100 feet a drive has been put in along the reef for a total distance of 300 feet, and a block 100 feet in length has been stoped out up to the surface. The reef averages some 10 inches in width, but is very irregular. Its dip, which also varies considerably, is to the east. A large quartzite dyke runs alongside the reef for some distance, and cuts across it occasionally without, however, displacing it at all. Fresh water was met with in this mine, it being one of the few mines in the district from which the water is drinkable.

The total stone crushed from this property to the end of 1902 is 1191·15 tons for 2,751·78ozs., being at the rate of 2·31ozs. per ton, and worth £3 14s. 6d. per ounce.

Table showing Gold Returns from Leases at Ularring up to end of 1902.

Name of Lease.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Block 45	692U	6·00	2·45	·41
Central Off Chance	351U	11·00	1·76	·16
Cuba	348U	4·00	14·55	3·63
Derby	666U.	101·25	193·28	1·91
Lady Emma	383U	10·50	11·00	1·04
Lady Betty	376U	10·00	4·90	·49
Matchless	346U	8·00	3·05	·38
Off Chance	338U	1224·50	2481·13	2·03
Puzzle	370U	37·00	28·78	·77
Shamrock North	371U	38·00	28·27	·74
Trio	360U	88·75	102·15	1·15
Yale Lock	406U	30·00	6·75	·22
Sundry Claims	...	6·00	2·70	·45

Mulwarrie District.

MOONSTONE G.M.L. 522U.—A small quartz reef runs almost due north and south through this lease; it has been worked at the north end of the lease by means of a number of shafts and short drives to a depth of about 70 feet. At this depth it is lost. The gold is found to occur in a series of short chutes which dip steeply to the north. The reef is from six inches to one foot in width, and runs vertically; it is crossed by several small granite and quartzite dykes, which run in a general north-west and south-east direction. Some of the stone obtained from these workings averaged as high as 10ozs.; they are at present abandoned, and prospecting is being carried on near the southern boundary of the lease in the hope of picking up another rich chute. The country is fine-grained greenstone, and becomes hard and settled at about 70 feet. Granite and quartzite dykes are numerous in the neighbourhood, and are mostly small. They generally run in a north-westerly to north-north-westerly direction.

Total crushings to end of 1902, 135·00 tons for 758·73ozs., an average of 5·62ozs. per ton, and worth £3 17s. 10d. per ounce.

MULWARRIE G.M.L. 9U.—Several shafts have been sunk on this property on a line of reef running about north-west and south-east. At present the reef is being worked from one of these, which is down to a depth of 320 feet (90 feet vertical, and the remainder underlay); from this shaft the lode has been stoped out for a length of about 120 feet from the 300 feet level to the surface. A main underlay shaft is at present being sunk on the reef about five chains farther south.

The lode averages from two feet to three feet in width, and dips at an angle of about 45 degrees to the north-east. It consists of a quartz vein with a varying thickness of schistose formation accompanying it. The quartz vein varies in size from a few inches to as much as five feet or six feet in some places, in which case it practically fills the space between the walls, only a very little of the schistose formation being present. This, though it carries a little gold, is not as a rule sufficiently rich to pay for crushing. The quartz is found sometimes on the hanging-wall and sometimes on the footwall. The hanging-wall is very even and well defined, while the footwall is not so regular, pinches in the lode being due to rises in this wall. The country is fine-grained greenstone, very soft and decomposed in the upper levels, but becoming harder and more compact from about 90 feet. Numerous granite and quartzite dykes run across the lode, principally in a north and south direction. These are mostly small, ranging from a few inches to several feet in thickness. As a rule they do not throw the lode at all, but it is generally found to be poorer in close proximity to them. Water was struck at about 310 feet (measured on the underlay). It is slightly brackish, but drinkable.

Total crushings to end of 1902, 1,963·49 tons for 5,870·25ozs., being at the rate of 2·99ozs. per ton, and worth £3 11s. 8d. per ounce.

North Mulwarrie G.M.L. 395u.—This property adjoins the Mulwarrie on the north, and the same line of lode has been worked on it to a depth of about 230 feet, measured on the underlay. Four underlay shafts have been sunk on the lode, the most southerly of which is only down about 70 feet, while the north or main shaft is down about 220 feet. About 50 feet of driving has been done from this south shaft, but it is not yet connected with the other workings. From the northern shaft about 400 feet of driving has been done at the lower levels, principally to the south, along the line of the lode. For the first 80 feet south from this shaft the lode consists of a talcose schist formation entirely free from quartz, and carrying only a slight trace of gold. South from this point the quartz begins to make and continues to the southern boundary of the property, averaging about two feet in width and dipping at an angle of about 45° to the east, and being similar in every way to the lode in the Mulwarrie lease. So far, no make of stone has been discovered to the north of the main shaft. As in the Mulwarrie, the lode is crossed by several granite dykes, which run between north-north-west and north-north-east, and vary in size from one to 10 feet.

Total stone crushed to end of 1902 is 1,168·00 tons for 1,977·35ozs., an average of 1·69ozs. per ton, and worth £3 17s. 10d. per ounce.

Killaloe G.M.Ls. 401u, 506u.—A small north-west and south-east reef runs through about the centre of this property, and has been worked to a vertical depth of about 120 feet by means of several underlay shafts, sunk on the reef, the deepest of which is about 160 feet, measured on the underlay. From this level the reef has been stoped out to the surface for a length of about 220 feet. It varies in size from almost nothing to about 15 inches, and dips to the east at an angle of about 45°. Associated with the quartz reef is from two to three feet of schistose formation, which usually carries a little gold, but not sufficient to pay for crushing. In the upper levels the quartz jumps from one wall to the other, but in the lower levels it keeps to the hanging wall, but is smaller and not so well defined as in the upper workings. The country is greenstone, soft and decomposed in the upper workings, but becoming very hard at the bottom levels.

Total crushings to end of 1902, 359·50 tons for 580·15ozs., an average of 1·61ozs. per ton, the gold being valued at £4 per ounce.

THUNDERBOLT G.M.L.—The owners of this property are working on a large felsite dyke which runs slightly west of north and east of south. On this dyke a shaft has been sunk vertically for about 45 feet, and levels driven north and south along the dyke for about 30 feet. A winze has also been sunk to a further depth of 15 feet. The dyke dips sharply to the eastward, and is from 20 to 30 feet wide. It carries a small amount of gold for its full width, as well as a considerable quantity of pyrites.

An irregular bunchy quartz vein runs along the hanging wall side of the dyke, and innumerable small quartz stringers run through it in all directions, forming a large stockwork. Some of the bunches of quartz are very rich, whilst others again carry only a trace of gold. Only these quartz bunches and the stockwork are being taken out at present. There have been no crushings to date, but the owners have about 80 tons of stone at grass, some samples of which, taken at random by myself and dollied, gave very good prospects.

About 12 feet north of the shaft the dyke is cut clean off by an east and west fault, and so far no attempts have been made to pick it up again in this direction.

ULARRING WESTRALIA G.M.L. 60.—Two quartz reefs run through this property, both striking about north-west and dipping to the east at a steep angle. There are several shafts on each line of reef. The western reef is some four feet in width, but is very broken and irregular, especially in the upper levels. It has been worked out for a distance of 150 feet down to a depth of 75 feet. There are two short chutes of gold in this reef, one dipping north and the other south.

The eastern reef, which is the only one being worked at present, is smaller, being from 18 inches to two feet in width, but is much more regular, and has much better defined walls than the western, and gives every promise of continuing to live to a considerable depth. It can be traced on the surface for about ten chains through this property, and also for a considerable distance into the adjoining lease on the south. It has been worked out down to 65 feet for a length of about 120 feet, the chute of gold in this case dipping at a rather steep angle to the south. The country is fine-grained greenstone, and gets very hard and compact at about 60 feet. There is a considerable quantity of pyrites in the quartz at the lower levels, carrying good values in gold.

This reef, like most of the others in this district, is intersected by several small granite dykes; these, however, do not affect the reef in any way.

Total crushings from this property to the end of 1902 are 497·25 tons for 971·60ozs., being at the rate of 1·95ozs. per ton.

MULWARRIE MAIN REEF G.M.L. 494U.—The main line of reef runs about north-west and south-east through the middle of this property. Five shafts have been sunk on this, two near the south end of the lease and three near the centre; of these latter the most northern is down 75 feet, the intermediate one 60 feet, while the third or main shaft is down 100 feet, 60 feet of which are vertical and 40 underlay. A winze has also been sunk a further distance of 20 feet from the bottom of this shaft. The lode has been worked out for 100 feet in length from the 70 feet level to the surface. A good deal of driving has also been done along the line of the lode at 100 feet, but no stoping. The lode, which dips to the eastward at a fairly steep angle, is from two to three feet wide, and consists principally of quartz, together with a little schistose formation on each side of the quartz. Occasionally the quartz pinches out to a few inches, its place being taken by the schistose formation, the walls still remaining the same distance apart. This formation is usually a good deal poorer in its gold contents than the quartz, but up to the present the greater part of it is being sent to the battery with the latter. The whole of the lode carries a considerable percentage of pyrites at the lower levels, a little galena being also present and being usually found only in the quartz. Small veins of calcite also run through both the lode and the country rock, which is a fine-grained greenstone, soft and decomposed to about 100 feet, but very hard and settled below this point. Water was struck at a depth of 115 feet (vertical) and is slightly salt.

A shaft has been sunk to a depth of about 50 feet on a small parallel quartz reef near the south-western corner of the lease, but no further work has been done upon it.

This property has crushed, to the end of 1902, 242·00 tons for 678·50ozs., being at the rate of 2·80ozs. per ton.

BUNINYONG G.M.L. 557U.—There are two parallel lines of lode running through this property in a north-west and south-easterly direction. The most western of these has been worked to a vertical depth of about 110 feet by means of several underlay hafts. This lode, which averages about two feet in width, and dips the eastward at an angle of about 60°, consists of soft highly-composed chlorite schist, with which is associated a good deal of quartz, usually occurring in bunches, some of them several feet in width, and generally very rich. A good deal of work has been done upon this lode, but it is at present (May, 1903) abandoned in favour of a small parallel lode some three chains farther east, on which a shaft has been sunk to a depth of about 25 feet, and about 20 feet of driving done. This lode is from six to twelve inches in width, and parts of it are very rich; it appears, however, to be cutting out at about the bottom of the shaft.

Total stone crushed to end of 1902 is 148·75 tons for 307·35ozs., including 11·00ozs., dollied and specimens, being at the rate of 2·06ozs. per ton.

Toledda, G.M.L. 644u.—Near the north end of this lease two shafts have been sunk to cut a small quartz reef which runs slightly east of north and dips to the east at an angle of about 30°. The reef averages from eight to twelve inches in width, but is very irregular, some bunches of stone up to three feet in width being met with; these, however, are generally very short.

The reef is crossed by several north and south faults, which run practically vertically, and generally throw it from three to six feet. The country, which consists of fine-grained greenstone, is very soft and broken down to about 80 feet, at which point it begins to get more settled and harder. The reef has been stoped out from the 50 feet level to the surface for a length of about 100 feet. The main shaft has been sunk to a vertical depth of 85 feet, and about 50 feet of driving and a little stoping has been done at this level. A small amount of pyrites is present in the stone from these lower workings.

At the south end of the lease several shafts have been sunk on a quartz reef striking north-north-west and south-south-east, and dipping to the eastward. A good deal of work appears to have been done on this reef, but it is at present abandoned, and no particulars were available at the time of my visit.

Total crushings to end of 1902, 81·00 tons for 100ozs., giving an average of 1·23ozs. per ton, worth £3 8s. 9½d. per ounce.

Oakley G.M.L. 308u, 391u, 442u.—This property is situated about three and a half miles south-south-west from Mulwarrie townsite. A number of shafts have been sunk, and a considerable amount of work done on a small quartz reef striking about north-east and south-west, and dipping at an angle of about 45 degrees to the east. The reef is at present being worked only from the most northern of these shafts, the others being for the present abandoned. This shaft is down about 150 feet on the underlay. At the 125 feet level about 75 feet of driving has been done along the reef southerly, and the reef stoped out from this level to the surface for a length of about 50 feet; no driving has been done northerly. The reef is patchy, and varies in size from a few inches to two feet—where seen it was from 10 to 12 inches—the walls, however, are clean and well defined. The country consists of fairly coarse-grained greenstone, and is very soft and decomposed down to the bottom workings, but not at all broken.

This property has, up to the end of 1902, crushed 1548·00 tons for 3430·46ozs., being at the rate of 2·21ozs. per ton.

Table showing Gold Returns from Leases in the Mulwarrie District, other than those already mentioned, up to the end of 1902.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Big Buck	363U	102·50	135·82*	1·32
Break o' Day	610U	57·00	13·00	·23
Cranbrook	581U (529U)	7·50	7·12	·95
Daimio No. 2	373U	24·00	63·93	2·66
Discovery	580U	136·00	63·05	·46
Dreyfus' Release	430U	32·20	27·25	·84
Dum Dum	452U	10·00	8·37	·83
Enterprise	561U	109·00	68·20	·62
Fairy Queen	377U	108·00	47·71	·44
Federal	449U	12·00	7·35	·61
Floral	402U (50U)	72·00	49·19	·68
Golden Star	550U (449U)	10·00	9·75	·97
Killaloe North	658U	15·00	15·00	1·00
Lady Emma	383U	10·50	11·00	1·04
Mona	400U (40U)	164·50	318·74	1·94
Mt. Egan's Big Gun	252U	2·00	6·70	3·35
Mulwarrie West No. 1	554U	11·00	4·10	·37
Mulwarrie Perseverance	474U	9·00	9·30	1·03
Pride of the Hills	627U	111·00	358·20	3·23
Pride of Wales	657U	14·00	6·00	·43
Q.E.D....	695U	8·00	12·60	1·57
Right Bower	419U	10·00	8·68	·86
Roseleaf	407U (366U)	74·50	128·86	1·72
South Mona	533U	41·00	122·35	2·98
Star	567U	19·50	25·65	1·31
Stella May	664U	9·00	5·45	·60
Stephenson's Big Gun	364U (252U)	74·00	72·32	·97
Sunnyside	607U	13·00	9·95	·76
Victerian	499U	33·00	12·70	·38
Welcome	520U (428U)	41·00	47·70	1·16
Sundry Claims	...	112·50	113·65	1·01

* Includes 3·82ozs. dollied and specimens.

Davyhurst District.

GOLDEN POLE G.M.Ls. 459U, 468U, 484U.—The main shaft on this property is down vertically to a depth of 300 feet, and levels have been put in north and south along the reef at 130, 200, and 300 feet. At the time of my visit the 300 feet level was full of water. At the 200 feet about 150 feet of driving has been done, principally south, and at the 130 feet about 400 feet, 250 feet south and 150 feet north. No stoping has been done to date. Two old underlay shafts are also down on the reef, the deepest being 160 feet. The reef, which is of white quartz, has a general trend slightly west of north and east of south, and is about two feet in width on the surface, gradually widening to about four feet at the lower levels; it dips steeply to the east near the surface, but in the bottom workings is practically vertical.

At about 100 feet south from the main shaft the reef takes a sudden turn almost due east for about 60 feet, and then southerly again on its original course for another 150 feet, when it is cut off by an east and west fault, dipping steeply to the north. So far, no attempts have been made to pick it up again beyond this point. A considerable quantity of pyrites is present in the stone at the lower levels, and a good deal of manganese is associated with the quartz on the walls of the reef, especially in the upper levels. Water was struck at about 280 feet, and is salt. The country rock is a fine-grained greenstone, very hard and compact in the lower levels, but soft and decomposed down to about 130 feet.

Stone crushed to the end of 1902, 1,004·00 tons for 2,599·85ozs., an average of 2·58ozs. per ton.

Homeward Bound G.M.L. 441u.—Several lines of reef run through this property in a north-north-west and south-south-east direction. These reefs are bunchy, and in places run up to six feet in width; their dip is vertical. Very little work has been done on any of them, the deepest shaft being only down about 50 feet. The lodes consist almost entirely of quartz, with several inches of hornblende schist on the walls; this schist usually carries very good gold. The stone is very heavily mineralised after about 30 feet from the surface. The country is very hard, compact greenstone, the zone of weathering only extending down about 30 feet.

Total crushings to the end of 1902, 151·00 tons for 102·15ozs.

Homeward G.M.L. 440u.—The main shaft on this lease is down 95 feet vertically. A crosscut has been put in westerly at this level for a distance of 40 feet, when the reef was cut. This reef has been driven on for from 15 to 20 feet northerly; it consists of a quartz vein some 18 inches in width, with several inches of schistose formation on the walls, and dips at an angle of about 75° to the west.

A second shaft has been sunk on a second line of reef farther east to a depth of 100 feet, and the reef stoped out for a length of 75 feet from the 100 feet to the 50 feet level. Above this level the stone is of too low grade to pay to take out.

This property has, up to the end of 1902, crushed 157·00 tons for 288·80ozs., an average of 1·84ozs. per ton.

Waihi G.M.L. 438u.—Three parallel lines of lode run through this lease in the prevailing north-west and south-east direction. On the most westerly of these a main shaft has been sunk to a vertical depth of 285 feet. Levels have been put in at 275, 200, 100 and 50 feet, and a good deal of stoping done at the two upper levels. This western ore body is some 100 feet in length, and is from two to four feet in width. It consists principally of quartz with varying thicknesses of schistose formation on the walls. At the lower levels very little quartz is present, and the formation carries only a very small amount of gold. In the upper levels the stone was very good, and some rich parcels were taken out.

Water was struck in the main shaft at 280 feet, and is salt. On a second lode, a couple of chains farther east, a shaft has been sunk to a depth of 100 feet, and a winze put down a further distance of 30 feet. A little driving has been done at the 100 and 50 feet levels, and a little stoping has also been done at the latter level. The lode, as opened up in the lower levels, consists of a rather irregular quartz reef some four feet in width, running vertically. Near the surface it is only about two feet. The country here gets very hard after about 50 feet. A small quartz reef, which appears to be a continuation of this one, has been worked at the extreme north end of the lease to a depth of 60 feet; not very much work has been done on it, however. A shaft has also been sunk to about 80 feet on a third line of reef still farther east, but no work beyond this has been done on it.

Total stone crushed up to the end of 1902 was 1,015·50 tons for 2,171·47ozs., including 5ozs. dollied and specimens, being at the rate of 2·13ozs. per ton.

Eileen G.M.L. 458U.—The owners of this property are working on a large irregular lode, running about north-north-west and south-south-east, and dipping at about 60° to the west. The lode consists of a body of soft, highly decomposed chlorite schist, some six to eight feet in width, throughout which is disseminated a considerable quantity of quartz, both in the form of bunches and small veins running through the lode. It has no defined walls, and varies a good deal in size, being in one place as much as 20 feet in width. An underlay shaft has been sunk to a depth of 130 feet on the lode, which is here about six feet in width, and a drive put in along it at the 105 feet level for a distance of about 150 feet, and the lode stoped out for about 50 feet up from this level. The chute of gold at present being worked is about 150 feet in length, and dips to the north at a fairly flat angle. A main vertical shaft is being sunk a few chains to the north-west of the present workings. This is now (June, 1903) down about 200 feet. Salt water was struck in it at about 170 feet, at which point the country begins to get hard, being very soft and decomposed down to this point.

This property, up to the end of 1902, has crushed 1,867·00 tons for 2,435·12ozs., being at the rate of 1·30ozs. per ton, the gold being valued at £4 0s. 6d. per oz.

Oasis R.C. 92u.—The lode in this lease runs almost north and south, and dips to the westward at an angle of about 45°. It is very similar to that in the Eileen, consisting of a belt of highly decomposed schist averaging some four feet in width. It is very irregular, being as much as 10 feet in width in some places, and has no defined walls. A good deal of quartz is associated with it, occurring in bunches and small veins throughout the lode. The chute of gold being worked at present dips at a flat angle to the north. The lode is at present being worked from a shaft sunk to a depth of 65 feet near the south end of the lease. Two sets of levels have been put in from this shaft, one at 30 feet for a distance of 50 feet north, and one at 65 feet for 100 feet. Very little stoping has been done from either of these levels. There are also several other shafts farther north on the lode, the deepest of which is down vertically 165 feet. These are at present abandoned, but a good deal of work appears to have been done from them. Water was struck at 165 feet, and is salt. The country, as far as opened up, is very soft decomposed greenstone. Several other small shows are also working on this same line of lode farther to the south.

Great Ophir, G.M.L. 613u.—This property is situated about a mile and a-half to the north-east of Davyhurst township. There are four shafts on it, the deepest being about 90 feet. Of these shafts, one is vertical and two are partly vertical and partly underlay, while the fourth is a new shaft somewhat to the west of the others, which the owners intend sinking to a depth of 200 feet in order to try and obtain a supply of water. The country, as far as tested, is very soft, and consists of highly decomposed greenstone. There are several parallel lines of lode running across the lease in a general west-south-west and east-north-east direction. These vary in size from a few inches to about four feet, and consist of bands of highly foliated greenstone—probably old faults or joint planes—much decomposed, and carrying a considerable amount of oxide of iron, and throughout which a fair quantity of quartz is disseminated. The gold is found, for the most part, as very thin scales on the faces of the cleavage planes of the schists, and is extremely light and difficult to save on the battery plates. The main line of lode at present being worked averages about four feet in width, and dips at a flat angle to the north. Only a small amount of driving and stoping has been done on it. In the main vertical shaft a large body of brecciated quartz was met with at about 80 feet. At the time of my visit it was impossible, owing to no work having been done upon it, to say what the size of it was, or in what direction it was running; it may, however, be the continuation of a small north and south quartz reef which outcrops on the south end of the property, and on which a little work has been done to a depth of about 20 feet. This reef is here about 12 inches in width, and runs on a bearing of 340°; its dip is vertical, the stone is bluish quartz, and shows coarse gold freely.

Crushings to end of 1902, 99·00 tons for 72·30ozs., being at the rate of ·73oz. per ton.

Table showing Gold Returns from Leases in the Davyhurst District, other than those already mentioned, up to the end of 1902.

NAME OF LEASE.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Champion	485U	36·00	17·30	·48
Forget-me-not	460U	176·00	440·24	2·50
Glengarry	465U	14·00	14·65	1·05
Golden Lode	691U	87·00	83·90	·96
Hanover	564U	47·00	40·40	·86
Hypatia	563U	50·00	23·20	·46
Jubilee	680U (620U)	39·00	33·00	·84
Lady Kate	697U (455U)	23·00	32·05	1·39
Macedon	659U	24·00	16·35	·68
Melrose	686U (439U)	35·00	95·35	2·72
Metalline	604U	54·00	39·50	·73
Three Hills	572U	40·00	2·20	·05
Waihi Consols	496U	73·00	168·30	2·30
Waihi North Extended	479U	11·00	44·75	4·06
Warne's United	491U	3·30ozs. dollied and specimens		
Sundry Claims	...	305·05	263·07*	·86

* Includes 1·40ozs. dollied and specimens.

SUMMARY.

In conclusion, it will be seen from the following table that the average gold yield from the district per ton of ore treated is an exceptionally high one, and also, as the ore value diagram shows, the total gold production for the whole Ularring district has been steadily increasing every year. There is no reason why, with systematic mining, together with the erection of suitable machinery, this increase should not be multiplied many times during the next few years.

Synoptical Table showing total Gold Yield from the District comprised within the boundaries of the map, up to the end of 1902.

—	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Mulline	26,198·22	36,439·88	1·38
Ularring	2,766·15	5,632·55	2·04
Mulwarrie	7,501·69	16,464·08	2·18
Davyhurst	5,307·55	8,986·25	1·69
District generally—			
Being sundry parcels treated at Mulline and Mulwarrie State Batteries	47·00	2,027·90	...
Returns from voided leases	2,968·30	4,074·67	1·37
Total	**44,788·91**	**73,625·33**	**1·64**

CHAS. G. GIBSON,
Assistant Geologist.

APPENDIX I.

List of Specimens obtained from the Ularring District.

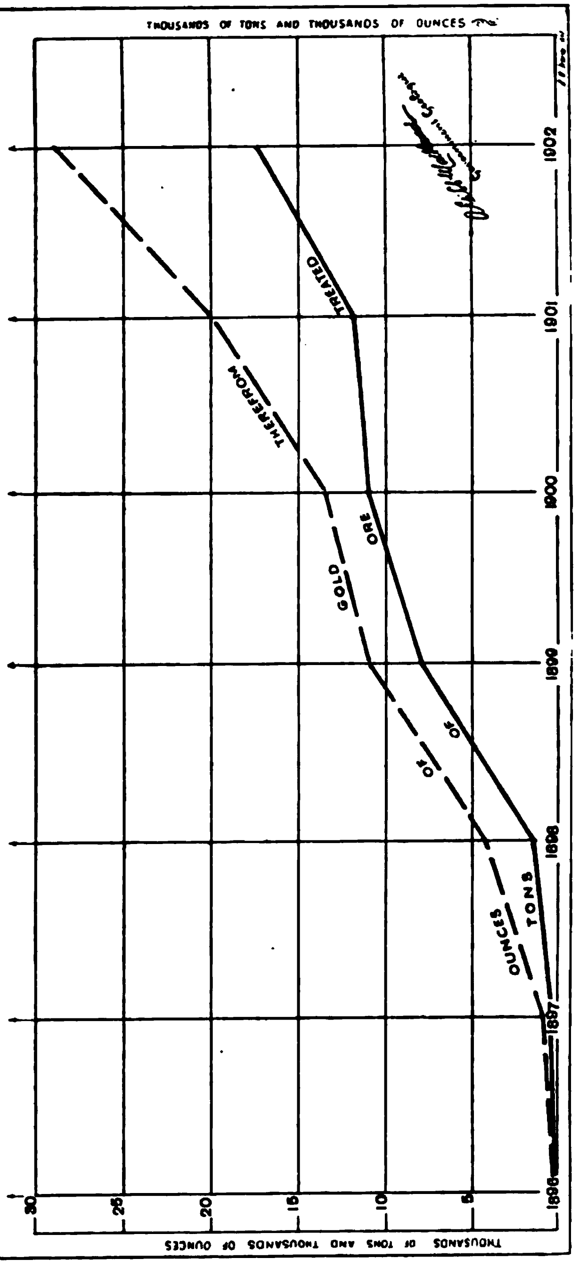
Registered No. of Specimen.	Registered No. of Microscope Section.	Name of Specimen.	Locality.
5008	337	Felsite (dyke rock)	20 chains west of G.M.L. 3632, Ularring
5009	...	Felsite (dyke rock)	2 chains south from above
5010	338	Diorite	G.M.L. 3632, Ularring
5011	339	Diorite	30 chains S.S.E. of G.M.L. 358, Ularring
5012	340	Granite (dyke rock)	G.M.L. 311, Ularring
5013	...	Laterite	G.M.L. 309, Ularring
5014	341	Biotite granite ...	Ularring Rocks, Ularring
5015	342	Felsite (dyke rock)	Thunderbolt G.M., Mulwarrie
5016	...	Granite (dyke rock)	G.M.L. 506, Mulwarrie
5017	...	Gold in schist ...	Great Ophir G.M., Davyhurst
5018	...	Copper Ore ...	G.M.L. 4550, Ularring

APPENDIX II

ULARRING DISTRICT

ORE VALUE DIAGRAM

Shewing Nº of Tons of Ore treated and Nº of Ounces of Gold obtained therefrom for each year since 1896



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CORRIGENDA.

Inside Cover Page, line 20:
for " a Gibb Maitland," *read* " A. Gibb Maitland.

Page 4, line 2:
for " face page 4," *read* " face page 1."

Page 4, line 11:
for " face page 26," *read* " face page 25."

Page 4, line 12:
for " face page 24," *read* " face page 28."

Page 4, line 23:
for " face page 28," *read* " face page 30."

Page 10, line 29:
for " South-Eastern corner," *read* " South-Western corner."

Page 25, line 21:
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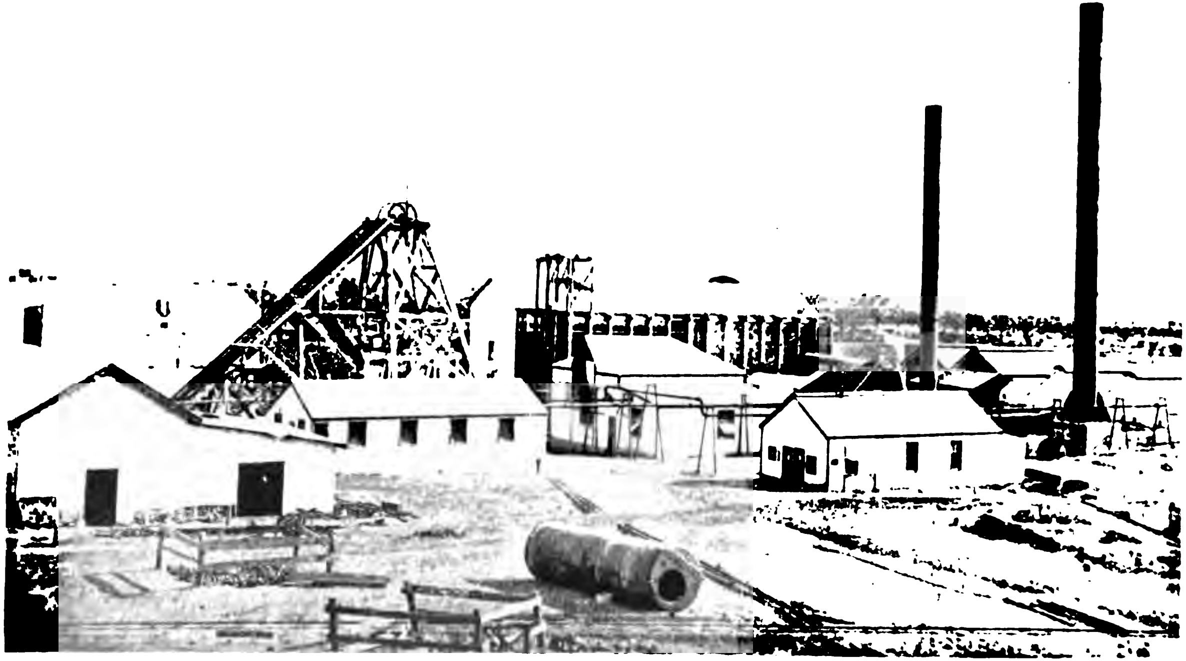
Page 25, line 21:
for " While in the vicinity of the workings in the Greenstone," *read* " In the vicinity of the workings it is in the Greenstone.'



The Sons of Gwalia Mine and Reduction Plant.

1904.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 13.

GEOLOGY AND AURIFEROUS DEPOSITS

OF

LEONORA,

Mount Margaret Goldfield,

BY

C. F. V. JACKSON,

ASSISTANT GOVERNMENT GEOLOGIST.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

WITH MAP AND SHEET OF SECTIONS.

PERTH:
BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.
1904.

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PREFATORY NOTE.

THIS report on the Geology and Auriferous Deposits of Leonora is one of a series designed to treat of the different important mining centres of the State. No previous detailed report has been issued on the district, although reference has been made to it by Sir John Forrest in 1869, and Mr. S. Gōczel in 1894. The present report is the first which contains a geological map and sections of Leonora. The field work, upon which Mr. Jackson's work is based, was commenced on the 7th of July, and concluded on the 10th of October. The area embraced by the work extending over about 70 square miles.

The rocks of the district comprise a complex of crystalline schists which form the continuation of that group which is so largely developed in the other portions of the Eastern Goldfields, and are no doubt of the same geological age, viz., Archæan. Detailed mapping, however, has been rendered difficult by the cover of superficial deposits which occupy such an extensive area, and effectually conceals important geological boundaries often in critical localities.

According to Mr. Jackson's observations, it appears that the crystalline schists comprise both basic and acidic rocks. The basic rocks, which comprise the main auriferous series, form a belt of about an average width of one mile, and a proved length of 10 miles. This belt, however, extends much further to the North and South than the area embraced by Mr. Jackson's work. Some of the basic rocks (greenstones) have been converted into schists which are largely developed along the outer margin of the main belt, whilst the centre portion is occupied by more or less massive rocks. There seems good reason to believe that the foliated and schistose rocks are merely portions of one and the same mass which have suffered more or less dynamical metamorphism, possibly modified by chemical action.

All the important ore deposits are confined to the greenstones and their derivatives, which have yielded fully 95 per cent. of the total output, and on that account are worthy of careful investigation.

The greenstones have been invaded by granitic rocks, which latter occupy by far the most extensive area of country examined. The acidic rocks are both massive and foliated; it has, however, not been found possible to, in all cases, separate the different varieties. It is, however, quite possible that more detailed examination than was deemed expedient would result in the recognition of two distinct series of granitic rocks, (*a*) an older, traversed by zones of secondary shearing, possibly associated with auriferous quartz reefs, and (*b*) a much newer and comparatively unmodified granite, which may be represented by the felsite dykes, which traverse the greenstone schists in the north-west corner of the area in the vicinity of the Leonora Gold Blocks.

The exigencies of field work prevented detailed petrographical work being carried out, but a series of rocks have been sliced, and as opportunity offers they will be microscopically examined.

The granites and greenstones are covered in places with lateritic deposits, a high and a low level laterite having been recognised, but it has not been found possible to separate both on the map, hence the two varieties have been distinguished by the same colour and symbol.

The ore deposits have been conveniently divided into four classes, particulars of which are fully set forth in the text.

The report is accompanied by schedules of gold returns prepared from the latest official statistics; these demonstrate that from the area embraced by Mr. Jackson's work there have been raised, up to the end of 1903, 331,824·92ozs. of gold, the result of the treatment of 420,792·50 tons of quartz, being at an average rate of 0·78ozs. per ton.

The report, map, and sections, having been submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

The index to names, places, mines, reefs, etc., occurring in the report, has been prepared by Mr. H. W. B. Talbot, the Field Assistant.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 4th February, 1904.

GEOLOGY AND AURIFEROUS DEPOSITS
OF
LEONORA
(Mt. Margaret Goldfield).

INTRODUCTION.

History of the Mount Margaret Goldfield.

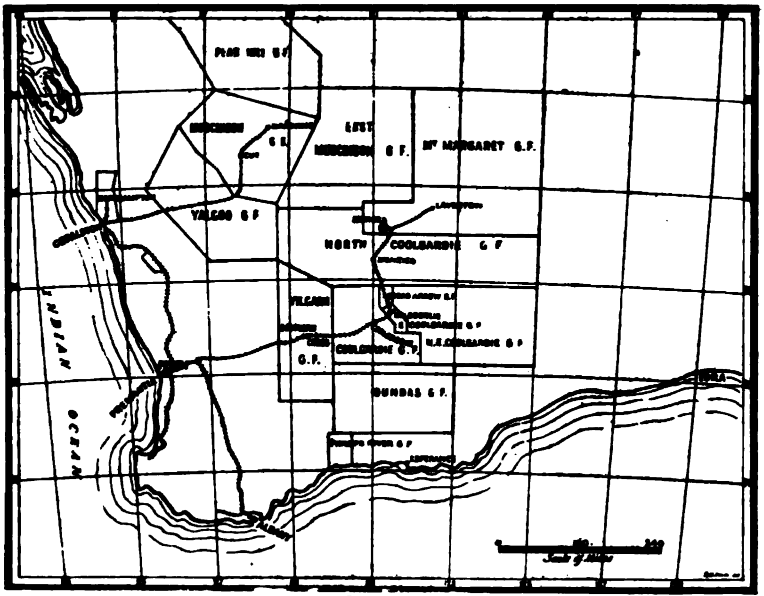

FIG. 1.--LOCALITY MAP.

PRODUCTION.

The following is a tabulated statement of the gold production of the total ore of the Mt. Margaret Goldfield, as defined by the authorities:—

	oz.	£
Previous to 1897	4,992·10	18,471*
1897	22,592·09	83,591
1898	49,717·77	183,956
1899	79,923·72	295,718
1900	145,688·75	539,048
1901	190,032·15	703,119
1902	211,308·77	781,842
1903	212,490·60	786,215
Total	916,745·95	£3,391,960

---

* Value of gold, assumed, £3·70 per oz.

The route followed by Sir John Forrest, when commanding the West Australian Expedition in search of the remains of Dr. Leichardt and party, crossed the now existing boundary of the Mt. Margaret Goldfield, near the South-Western corner, and the history of the country comprising its area commences, geographically speaking, with following extract from the explorer's diary of the expedition:—

> 24th June, 1869. . . . . . "From the summit of a remarkable peak, which I named Mt. Flora, I obtained a round of bearings, and saw a high range bearing about north 106° east mag., apparently about 16 miles distant, towards which we travelled till after dark.
>
> "25th. . . . . . Saddled at dawn and proceeded to the range, about five miles distaut, and on reaching it I ascended the highest peak, and named it Mt. Margaret."

From that date but little further knowledge was gained of the country, or, indeed, little attention paid to it, for more than 20 years; and it was not until 1894 that the Mt. Margaret, or Lake Carey, country began to be regarded as a prosperous and rising district.

In a report on the Interior Gold Region of Western Australia, (*) published in 1894, Mr. S. Göczel, describing the country passed over on an expedition from the "Ninety Mile" to Lake Carey, mentions the Lake Raeside depression, which he crossed some miles to the south of Mt. Leonora, and which forms the drainage area of the southern portion of the field. He noted the position of the large outcrops of granitic rocks, which rise as a range of bare hills to a height of 200 feet above the surrounding country, and form, with a width of about five miles, the divide of the watershed of Lakes Raeside and Carey. Mr. Göczel further stated that a long stretch of country, situated at the junction of this gneissic granite on the west, and greenstone on the east, had already been proved auriferous, and he mentioned the "Red Castle" line of reef and the "Goose's Puzzle," and stated that, though rich finds had not been made up to that time, a number of reefs offered chances for profitable mining enterprise.

Farther east, on the range of which Mt. Margaret forms the highest point, he referred to alluvial gold deposits at Red Flag, Hawk's Nest, and other surface workings, the Hawk's Nest being the richest.

At the end of 1895 the population of the whole of this large district amounted to 730, while there were 3,400 acres held under mineral lease, and two 10-stamp batteries situated at Mt. Margaret.

During 1896 numerous new finds were reported, viz., Mt. Margaret, Mt. Malcolm, Mt. Leonora, and Murrin Murrin, all then within the North Coolgardie Goldfield; and it was not until the 1st April, 1897, that Mt. Margaret was constituted an independent lfield, formed by separating portions of the North Coolgardie and Murchison Goldfield, and having an area of 42,154 square miles.

---

* Report on the Mines Department. Perth: By Authority, 1895.

Apparently, at the time, the centre of Mt. Malcolm gave promise of being the most important, and the Warden's Office for the transaction of the departmental business of the new field was opened there on the 10th May, 1897, the area being divided into the two districts of Mt. Margaret, 17,150 square miles on the eastern side, and Mt. Malcolm, 2,516 square miles on the western side.

In the same year the Westralia Mt. Morgans Gold Mines was registered as a local company, and on the 3rd March following the Sons of Gwalia, Limited, which gave a great impetus to the mining centres of Leonora and Morgans, these two mines being now the chief producers of the field. The Under Secretary for Mines, in his Annual Report for 1898, refers to the developments of the field during that period as being little short of phenomenal.

During 1899 a public battery started operations at Leonora, and further copper deposits were found and furnaces erected at Anaconda, in the vicinity of Murrin, where similar ores had been previously located. The yield of gold for the year amounted to 5 per cent. of the total production of the State. Developments were almost equally satisfactory in the following year, 1900, especially in the vicinity of Mount Margaret, and to the east and south-east of Laverton; and 4,539 tons of copper ore were treated at Anaconda. The gold yield rose from 5 per cent. to 9·6 per cent. of the State's total production, a proportion which increased to 10·3 in 1901, when the copper output from Murrin, valued at £40,738, amounted to rather more than half the State's total. The Warden of the field reported, at the end of 1901, that progress was marked more by attention to legitimate development of prospecting shows and mining at a depth than by the opening up of new country; remarks which apply also to the following year, when, however, the yield of copper showed a falling off, and the output was only valued at £6,852.

The gold production, nevertheless, maintained a satisfactory increase, and in April, 1902, a slight alteration was made in the administration of the field, by the creation of the new district of Morgans; the centres being now Malcolm, Morgans, and Laverton, the relative importance of which, as producers, is shown by the following comparative statement:—

1902.

District.	Population.	Production.
		oz.
Malcolm (including Leonora) ...	2,170	88,842·92
Morgans	1,114	59,091·55
Laverton	2,741	63,374·30

It appears, therefore, that since 1896 the record of the field has been one of continuous prosperity. A number of townships have grown up round the more important mines, and while the population of the field has increased from 730 to 6,025, the annual gold production in the same period has risen in value from £83,591 in 1897, to £781,842 in 1902.

It is not inappropriate to add that, speaking generally of the country passed over on his expedition in 1869, Sir John Forrest remarked: " As for minerals, I am not sufficiently conversant with the science to offer an opinion, except that *I should think it worth while sending geologists to examine it thoroughly.*

LEONORA DISTRICT.

HISTORY.

The following table shows the total gold production of the Leonora District:—

PRODUCTION.

	Ozs.	£
Previous to 1897	112·10 ...	415[*]
1897	9,056·91 ...	33,511
1898	19,475·37 ...	72,059
[†]1899	27,673·87 ...	102,393
[‡]1900	60,084·61 ...	222,313
1901	72,008·18 ...	266,430
[§]1902	68,804·58 ...	254,577
1903	74,609·30 ...	276,054
Total	**331,824·92** ...	**£1,227,752**

The township of Leonora is the present terminus of the Eastern Goldfields Railway, situated 323 miles to the east and 225 miles to the north of Perth.

The Leonora district forms portion of and occupies the south-eastern corner of the Mt. Margaret Goldfield, and its early history therefore also begins with the West Australian Exploring Expedition in 1869; not merely in a general sense, however, but, as is worthy of note, the country was traversed and examined in some detail. Quoting the paragraph from Sir John Forrest's memoirs especially referring to the locality:—

---

[*] Value of gold, assumed, £3·70 per oz.

[†] Ten stamps working at Sons of Gwalia.

[‡] Sixty stamps working at Sons of Gwalia.

[§] Sons of Gwalia output diminished. Mining costs decreased, profits increased.

> 20th June, 1869. . . . . . "From a bare granite hill about one mile from camp, I saw a high hill bearing north 81° 30′ east mag. about 25 miles distant, which I named Mt. Leonora; and another bearing north 67° east mag. about 25 miles distant, which I named Mt. George. Intend proceeding to Mt. Leonora to-morrow."
>
> 21st June. . . . . . "Steering towards Mt. Leonora, over some tolerably grassy country, we reached it at sundown, and not finding any water, camped without it, with very good feed; in south latitude 28° 53′ by meridian altitude of Lyræ (Vega) and Aquilæ (Altair), and in longitude about 121° 20′ east."

Thus is recorded the earliest history of the landmark from which the district derives its name.

In tracing its mineral history, it seems probable from what has already been said with regard to the Mt. Margaret goldfield generally, that the deposits mentioned by Mr. Göczel in 1894 include all those which were first known within its boundaries, and it is unlikely that there was then any mining in the district; though alluvial gold appears to have been discovered by fossickers not long afterwards.

It is generally agreed that the first discovery of an auriferous formation which led to more extensive search, and ultimately brought to light the valuable deposits now being worked, was made in 1896, by two prospectors—Sullivan and Weddeck—who, like most pioneers, arrived on camels, probably from Menzies or Niagara, the then nearest centres.

They discovered gold showing in a quartz outcrop about one and a-half miles north-north-west of the present township. Their lease, No. 4048, now the site of the public crushing battery, and known as the Johannesburg, was applied for on the 11th March, 1896, and surveyed on the 18th November of the same year. It has been forfeited and held again at different dates and under different numbers, *i.e.*, 238T, 152C; but, except that a good deal of rich gold was obtained from a large boulder forming part of the outcrop, there is but little authentic information concerning it. After the rich surface stone was worked, however, and a shaft put down, the ore proved too low grade or the vein too small to be payable. Occasionally fossickers are said to have obtained small parcels, the returns of which are no doubt included in the statistics under the head of "Sundry Claims," with the exception of a single crushing in 1902 of eight tons, which yielded 5ozs. of gold.

The two original prospectors were followed closely by others, and the next find of importance was made by McPhie and party, who discovered a reef two miles farther north, and pegged out Lease No. 195C, known as the "Great Wonder," now the "Leonora

Gold Blocks." The application for this lease was made on the 3rd June, 1896, while that for Lease No. 4263, containing the outcrop of the Sons of Gwalia lode, appears in the official register dated the 2nd June, 1896, though which of the two takes precedence as regards the discovery of the deposit is not recorded therein.

A great number of leases were quickly taken up surrounding those held by the lucky prospectors, and, as shown by departmental records, the progress of the district as a mining centre has been extremely rapid: a result, however, in great part due to the richness of the Sons of Gwalia lode, and intimately connected with the development of that property on a large scale after its purchase from the prospectors by Mr. G. W. Hall in 1896 for the sum of £5,000.

From 77 per cent. of the total in 1897, the production of this mine had risen at the end of 1902 to 93 per cent.; and the total output of the field for the same years amounted to 9,057·17ozs. in 1897, and 68,804·58ozs. in 1902. The increment added by the public battery, which started operations in 1897, and has crushed to date 10,960·5 tons for a yield of 10,153·82ozs., amounts in value to £38,583·18.

The accompanying geological map comprises an area of 70 square miles, hereinafter referred to as "the district."

It is bounded by an east and west line at Mount George, 4½ miles to the north of Leonora, and by a similar parallel at Lake Raeside, 5 miles to the south. On the east and west by meridian lines 4 miles and 3½ miles from the township respectively.

PHYSIOGRAPHY.

Approaching Leonora from the south, the general appearance is that of a long ridge of more or less pointed hills, extending with a north-westerly axis to Mount George; and in a southerly direction beyond Mount Leonora to Lake Raeside. The altitude of Mount Leonora and Mount George, which form the most prominent features, being 250 feet and 225 feet respectively above the surrounding plains.

This ridge, running diagonally from north-west to south-east, forms a natural division of the district into two parts, which it has been found convenient to refer to in the following pages as the eastern and western side of the area.

On the west are wide flats extending with an imperceptible slope to the eastern side of the Lake Raeside saltmarsh, which stretches in a north-westerly and south-easterly direction for at least 100 miles, and of which the deepest parts are occupied by salt-water pools, and then dried up beds.

The country to the east, though largely occupied by flats, is rather more broken.

The district forms portion of the eastern watershed of Lake Raeside, the divide between this and the Lake Carey drainage area being approximately 12 miles to the east, while in a westerly direction, at a distance of from 4 to 5 miles, the country begins to fall towards the Lake Barlee Basin.

Mr. Göczel, in 1894,* writing of the Interior Goldfields of Western Australia, refers to them in general terms as being situated in a region having very slight, if any, drainage towards the sea: "Absorption, evaporation, and percolation to the saline flats and salt lakes balancing the rainfall." The altitude of Leonora, but slightly different from the other goldfields, is about 1,220 feet above sea level; and the annual rainfall of the district, so far as records have been kept, has varied from a minimum of three inches in 1897 to a maximum of 12·16 inches in 1900, or an average for the six years of 7·42 inches.

Relatively speaking, the district is well provided with water, that first met with in the mine and well shafts being freely made use of. This supply is generally obtained at about 60 feet, but at a shallower depth in the alluvium to the west, where several areas have been selected for cultivation. The water obtained from the upper levels, though containing a fair proportion of lime and magnesia salts, is used for boilers; and, suffice it to say, with certainly not more than the average inconvenience attendant on the use of such water on the goldfields, where the necessary boiler-cleaning resulting on the presence of a considerable proportion of solids has frequently to be undertaken.

Tanks are chiefly relied on for drinking water, but the township is provided with a gravitation supply, the water being obtained from a well and raised to an elevated reservoir by a powerful windmill pump.

GEOLOGY.

Broadly speaking, the district may be geologically defined as an area of crystalline schists; of which by far the greater portion is covered by recent superficial and alluvial deposits. These latter are in most cases derived from the accumulated detritus of the older rocks, while metamorphism has not in general been so great that the nature of the rocks themselves cannot be distinguished; and according to the acid or basic character of the original form, a geological division made conformable with the general scheme of rock classification.

In point of geological age, also, the rocks can generally be recognised as referable to, in fact, part of the same group so largely developed in the Eastern districts, and outcropping, as they do, at either one or another of the mining centres thus situated.

---

* *Ad interim* Report on the Department of Mines, 1894, pp. 24, 25. Perth: By Authority, 1894.

Geologists, writing of the Goldfields,* have described them as being divisible into three sections—Granites, Gneisses, and Schists; and on this basis have assigned a more or less definite position to each, thus:—

"The first auriferous belt of hornblende, mica, or talc schists (about 20 miles in width) extends from the Southern Cross Goldfields in a south-easterly direction to the south coast, and in a north-westerly direction to and beyond Cue, in the Murchison Goldfield.

"The second auriferous belt, similarly composed, includes Coolgardie, Kalgoorlie, and extends with a parallel axis, and with a width not yet explored, from Norseman on the south, through the Pilbarra Goldfield, to Egina and Mallina on the north-west coast.

"The Leonora District, in fact the whole of the Mt. Margaret Goldfield, is included within the second auriferous belt; the country between the belts and to the west being occupied by the above-mentioned granites."

At the same time the granites, gneisses, and schistose derivatives were classed as Archæan rocks, and have been most frequently thus spoken of by other geological observers; while the diorite, diabase, pyroxenite, with the hornblende and chlorite schists, have been most generally referred to as "paleozoic greenstone."

Both granite and greenstones are represented at Leonora, and an examination of the small area, though not affording any new evidence as to the exact geological age of the formation, raises the question of the ages of the rocks within it, in so far as the relation is concerned, of the greenstones to the granites, to which discussion in this respect is practically limited, for though each division undoubtedly contains more than one primary form, further separation is impossible owing to so large a proportion of the area being completely hidden from view, as well as to the highly decomposed state of the schists where outcrops can be examined.

The crushed rock forming Mount Leonora, as well as the smaller areas to the north and south, is no doubt of intrusive origin and of later age than the greenstones, as also probably the remainder of the granite area represented; but further evidence in support of the latter general conclusion would be more satisfactory.

SUPERFICIAL ACCUMULATIONS.

The development of recent accumulations in the district is very extensive, as indeed has already been noted on almost all our Eastern Goldfields; but there are many important features with regard to these residual deposits and their distribution at Leonora, where in one form or another they cover all except the most elevated areas.

On the eastern side, occupied by the granitic schists, the surface is covered by the usual soil resulting from the decomposition

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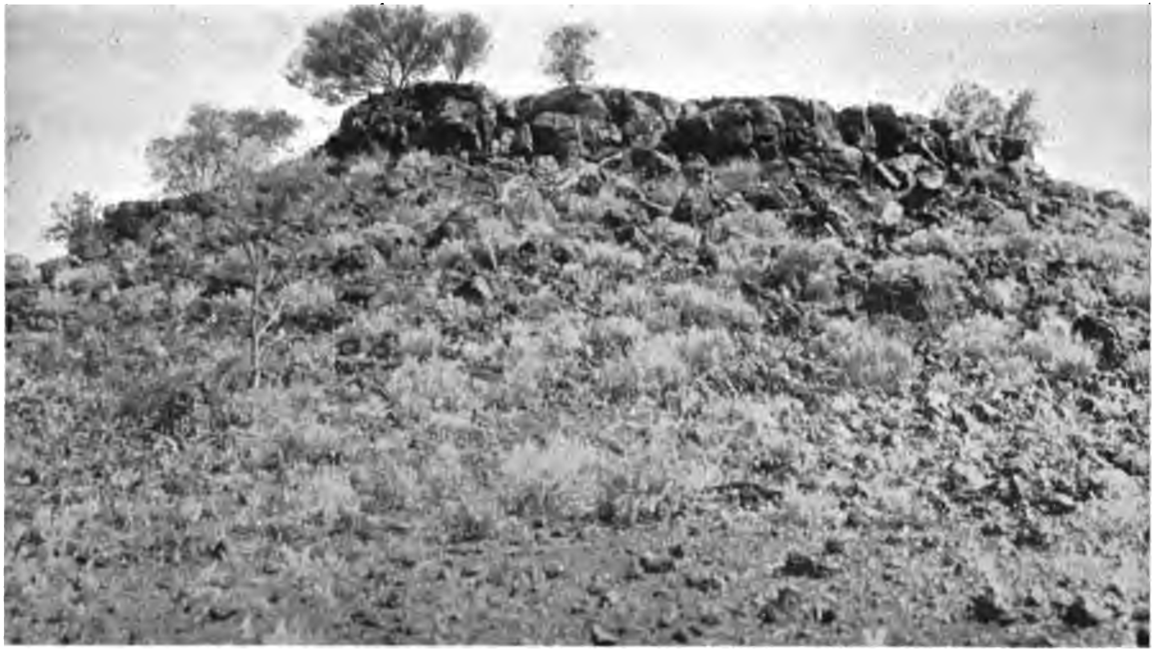
* Mining Handbook to the Colony of W.A. Harry P. Woodward, pp. 36, 37. Perth: By Authority, 1895.



High-Level Laterite, One Mile North-East of Mount George.

of the schists *in situ*, which, in the depressions, has accumulated to a very considerable deposit forming wide sandy flats. The higher portions, however, from which the finer products of degradation have been removed, are more frequently covered by quantities of ironstone, consisting of fragments of highly ferruginous clay, representing those portions which have become hardened, and charged, no doubt by a concretionary process, with the iron of the original rock mass, now become to a great extent bleached and decomposed.

On the western side the superficial covering is probably in great part more of an alluvial character, no doubt of considerably greater thickness; and to it, even now, are being added the more or less sedimentary accumulations of Lake Raeside. The waters of this lake, in addition to the deposition of mechanically suspended silt, have left in places, chiefly as a result of evaporation, a siliceous residue of lime salts, particularly at the outer margins. In some cases the lime is sufficiently free from other substances to form, when burnt, a local supply for building purposes, but as a rule is too impure.

Apart from the influence which the existence of the salt pools or lake may have had upon its present form, practically the whole of the material filling the depression on the western side appears to have been derived from the disintegration, *in situ*, of a previously existing residuary deposit, *i.e.*, the ironstone gravel, which bears a comparable resemblance to the laterite of such wide distribution throughout India and Ceylon.

This formation, the remains of which are shown on the map, either in the high level or low level form, no doubt not only covered the greater part of this area, but extended through the gap in the dividing ridge known as the "Gorge" for a considerable distance beyond the limits of the map. These laterites are a typical formation of the Eastern Goldfields, and both types are represented in the Leonora district. The high level form, of a dark brown colour, is the more highly ferruginous; and is often of pisolitic appearance, or shows a brecciated structure at the base, due to the detrital rock fragments becoming re-cemented into the mass, which may be a compact impure ironstone.

The deposit now only occurs in the form of detached outliers, sometimes presenting a vertical cliff face from 15 feet to 20 feet in height (Plate I.); and where the original surface can be examined, the highest portions are found to be at an elevation of from 80 feet to 100 feet above the mean surface level. This corresponds with the observations in the Coolgardie Goldfield, where a sample was found to contain, as oxide, the equivalent of 25 per cent. of metallic iron, and one recently collected in the neighbourhood of Boogardie, as much as 51·67 per cent. and 11·46 silica.

The low level variety is of much greater extent, and between the areas occupied entirely by this formation and the more recent alluvium, it is often difficult to differentiate on a merely superficial examination. The deposit is more of the nature of a ferruginous clay, which, by the development of concretionary structures, has become nodular, particularly in the upper portions, the iron ultimately appearing on the surface in the form of fine red dust and hard brown ironstone pebbles.

The origin of these laterites, both here and also in India, appears to have been a subject of some speculation; but of the deposits at present under discussion, while the low level varieties have in great part a detrital origin derived from the high level form, there is no evidence suggesting that the latter have been formed otherwise than *in situ*.

Underlying the deposits above described, and between them and the original rock masses beneath, there is almost always a thin stratum of calcareous material, locally called "cement," a formation which follows the contour of the rock surface and varies from a few inches to a few feet in thickness, and, being intensely hard, its removal requires the use of explosives.

This occurrence, also, is by no means uncommon, nor, indeed, limited to Western Australia, as a description of an almost identical occurrence has recently been published in the Transactions of the American Institute of Mining Engineers, Vol. XXXI.,* an article which supplies a comparison for those of our own State.

The material consists of an earthy limestone or travertine, often containing a breccia of rock fragments, and, like the other superficial deposits already mentioned, has been formed *in situ*. The cementing substance chiefly composing it has been derived from the decomposition of the lime-bearing minerals of the underlying rocks, and the process and formation one of solution and redeposition.

Finally, with regard to the superficial deposits as a source of gold—the first type only, *i.e.*, that covering the granite schists on the east, can be said to have yielded alluvial gold in the sense of the term ordinarily understood in Western Australia.

The others have only served to hamper the operations of prospectors, and often, even when the proximity of an auriferous reef has been proved by the occurrence of gold in the surface boulders of quartz "floaters," its position has never been located. That such remarkable success has been met with can only be regarded as an argument in favour of further expectations.

THE GREENSTONES.

The group of rocks comprising both massive and schistose forms to which the term greenstone is now being generally applied, have by far the greatest economic importance of any in the district; and with the extension of mining operations, an accurate knowledge of their extent and relation to the other rocks becomes second only

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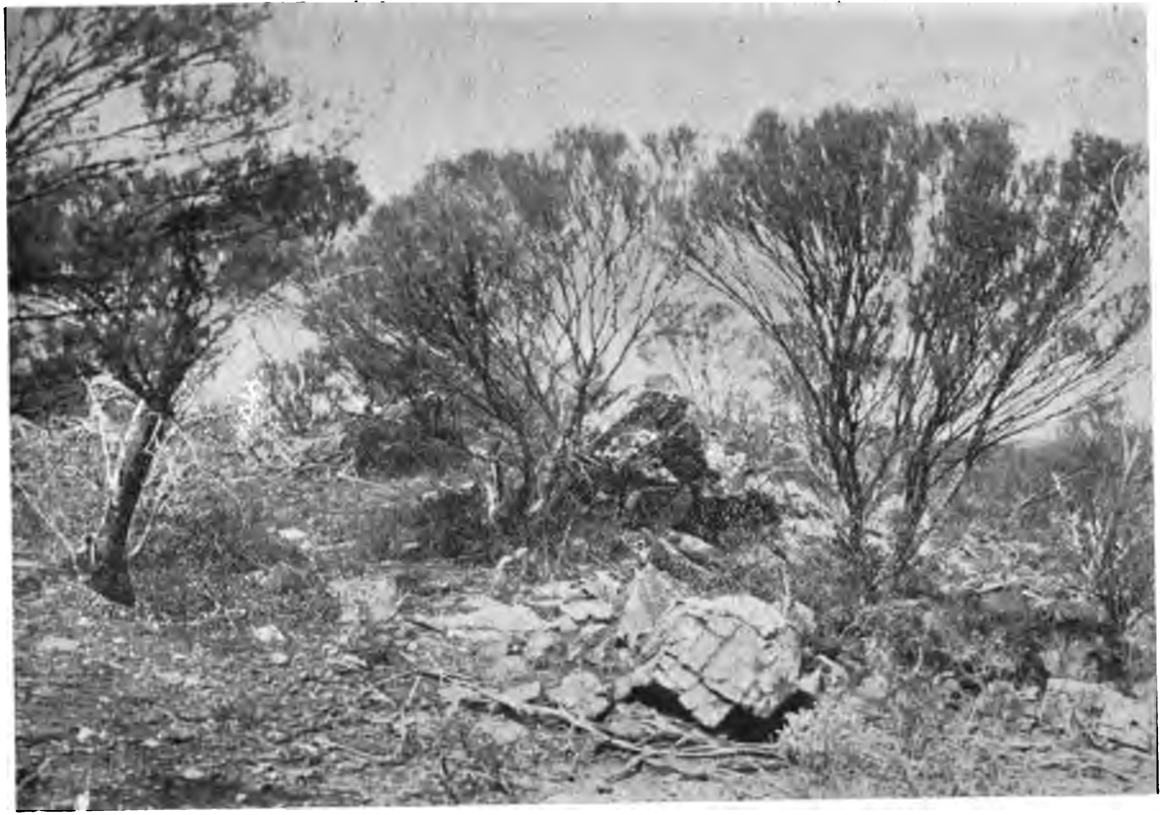
* The Caliche of S. Arizona, William P. Blake, Transac. Am. Inst. M.E., 1902, Vol. XXXI., pp. 220, 221.



Typical Outcrop of Banded-Quartz in Greenstone, One and a-half Miles South of Mount Leonora.

in importance to a knowledge of the ore-bodies within them, which yield from 60,000oz. to 70,000oz. of gold annually, or 95 per cent. of the total output.

The formation occupies a diagonal strip of the map, and must be regarded as a single area of basic rock, which has been more or less crushed, foliated, or completely converted into schists, the latter structure being on the whole the most usual, and to such schistose zones the auriferous reefs are almost entirely confined.

An examination of the area enables those portions which are occupied by the completely schistose rock, "greenstone schists," to be distinguished from those occupied by the massive and foliated greenstone; and furthermore, to the recognition of more than one variety of basic or ultra-basic rock; but not only is any further separation impossible, but, for reasons already stated, no satisfactory evidence is available with regard to the geological relation of the several varieties.

The greenstone schists are most largely developed on the outer margins of the main belt, in juxtaposition to the granite rocks, and, while the middle portion is occupied more or less by massive rocks, form two fairly well defined strips extending the whole length of the map. Those on the western side contain nearly all the important ore-bodies, and are of nearly the same composition, and similar in their characteristics, to the schists derived from similar rocks, "chlorite schists," occurring elsewhere.

The greenstone on the eastern side of the belt is found in an even higher state of metamorphism; a considerable development of the remarkable banded and hematite-bearing quartz forming one of the most noticeable features of the district. Along the summit of the ridge extending from Mount George to Leonora, and thence to Lake Raeside, outcrops of this quartz are found in the form of bands, or lenses, from 10 to 50 chains in length, and from 1 foot to 100 feet in thickness; and projecting several feet above the surface in the form of parallel-sided bars. (Plate II.)

They follow the general dip and strike of the schists, which have been altered by leaching and other processes for a considerable distance on either side; and appear to be similar to those at Bardoc, and to the occurrences mentioned in several reports on other goldfields, where their position is ascribed to "an old fault or line of joints along which the greenstones have been highly foliated." In the Boogardie and Lennonville Districts * they are auriferous, or associated with the auriferous deposits.

Their ultimate form seems to be due to a lode-forming process in the zone of weakness above referred to, but except in one instance at Leonora—"The Savanah Lode"—gold has taken no part in their mineralisation.

Specimens can be taken from the same outcrop of white quartz, of a banded quartz, and of a dark blue or grey compact variety

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* Lennonville, Mt. Magnet, and Boogardie, Bulletin of the Geological Survey of W.A., No. 8, pp. 16, 17; C. G. Gibson. Perth: By Authority, 1903.

having in a hand-specimen the appearance of a felsite; under the microscope, however, slices from specimens [**5101, 5102, 5222**]* appear wholly as minutely crystalline quartz, containing a little iron oxide; the different appearance being due to the arrangement of the latter in bands, or in the blue grey variety to a more minute quartz mosaic and a more even arrangement of the iron.

The massive and foliated greenstone occupies, roughly speaking, the centre of the greenstone belt, being much more prominent at the northern end than at the southern end of the field, and an examination of the outcrops for specimens, which might serve as a guide to the original nature of the rock, does not furnish satisfactory evidence, since in almost every instance the rock is too decomposed for microscopic examination.

The best preserved specimen [**5088**]* consists of decomposed hornblende with plagioclase, and has been essentially a hornblende rock, while in sections of the others, which are all more or less crushed, the ferro-magnesian mineral shows complete conversion into chlorite; and the rock slices under the microscope are similar in appearance to those cut from specimens of the greenstones occurring at Coolgardie and Kalgoorlie, which have already been described in detail.†

One specimen only need be referred to [**5098**], which is in a very fresh condition, the rock being a diabase consisting of ophitically-arranged plagioclase and augite. I think it probable, however, that this rock is of later age than the basic rocks elsewhere. The specimen was taken from an outcrop of large round boulders occurring in an area of greenstone near the junction of the telegraph lines to the north-east of Leonora, and the outcrop itself occurs on a flat, and is surrounded by superficial deposits; but the remainder of the area, of which an examination is possible, consists of a rock similar to that occurring elsewhere.

THE GRANITIC ROCKS.

The existence of natural boundaries, as well as the considerations already referred to with regard to the greenstones, renders it advisable to similarly separate the granitic rocks into subdivisions of massive or foliated and completely schistose, though rocks are found grading from one type to the other.

The massive and crushed rock in which the original granitic structure can be recognised lies on the west, forming as it were a buttress, against which has been thrust the more schistose country to the east. Mount Leonora, with an elevation of 250 feet, forms a striking example of an intermediate stage of crushing and alteration (Plate III.), the rock having assumed a laminated form due to the pressure and weathering into large, more or less, rectangular blocks. Other small areas occur to the north and south, and appear—the

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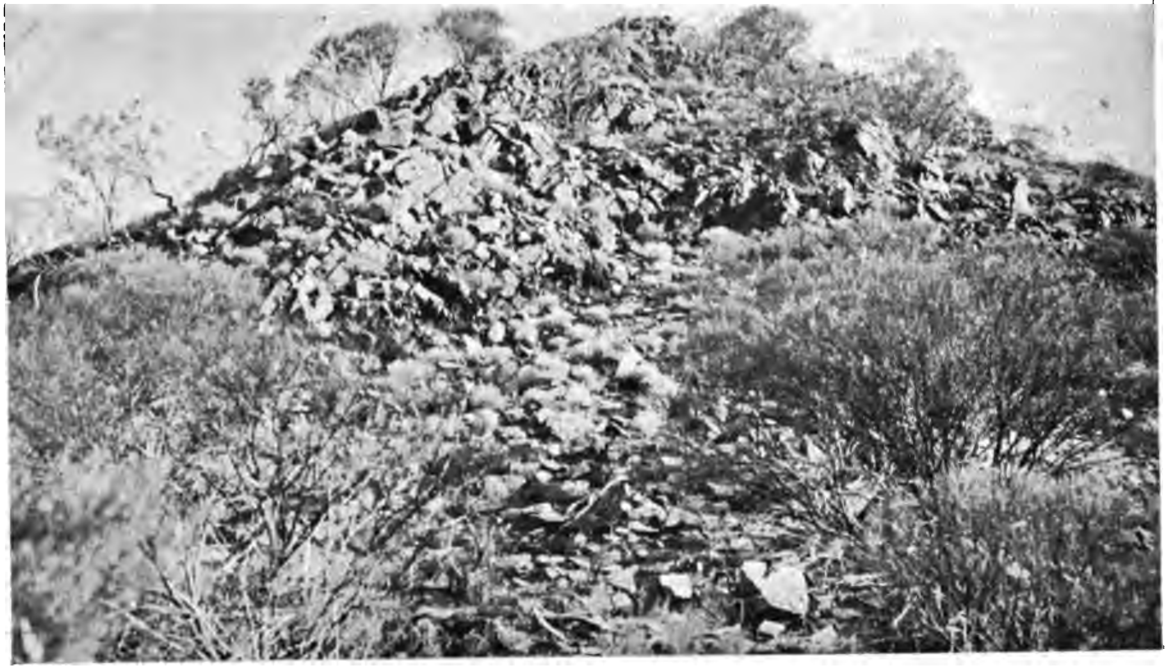
* The figures in heavy type [**5088**] throughout the report refer to the numbers of the specimens as entered in the Departmental Collection Register.

† Notes from the Departmental Laboratory, Geological Survey of W.A., Bulletin No. 6 pp. 62, 63. E. S. Simpson. Perth: By Authority, 1902.



Mount Leonora.--Outcrop of Crushed Granite; Dip, 55 degrees East.

southernmost one, at least—to be completely included in the greenstone; but owing to the general leaching and alteration which has taken place, it is difficult to determine this point with certainty. The relation of these rocks to the greenstones has already been referred to on page 17.

Outcrops to the west are few, but the specimens collected show the predominating rock to be a gneissic granite; and the ferro-magnesian mineral, of which it appears to contain in some cases very little, was no doubt chiefly a dark mica.

The area to the east is distinguished from that to the west by the original form being in no case recognisable, and also by the extent to which the rocks have been effected by the agencies of decomposition. The result appears to be general, but there is a zone within the formation in which the process has continued to a very great depth. The original rock comprising this zone consisted, in its metamorphosed form, of a white fine-grained micaceous schist, and no doubt several varieties of granitic rocks occurred in the area; but the chief development has been that of a porphyry.

Sections Nos. 410, 411, of specimens [**5096**] and [**5097**] show under the microscope a minutely crystalline base with porphyritic quartz, No. 411 showing both porphyritic quartz and felspar—a quartz felspar porphyry. As far, however, as any evidence of relative geological age is concerned, these schists must be classed with the granites.

The following table gives a series of analyses made in the Survey Laboratory, under the direction of the Mineralogist and Assayer, of different varieties of the rocks referred to above:—

Table of Analyses of Rocks from Leonora District.

	G.S.M. **5,089**	G.S.M. **5,088**	G.S.M. **5,087**	G.S.M. **5,086**	G.S.M. **5,099**	G.S.M. **5,084**
SiO_2	47·70	50·98	42·17	53·09	76·22	76·71
CO_2	1·85	*Nil*	6·70	6·33	*Nil*	...
TiO_2	·52	·79	·55	·98	·86	·66
H_2O (Comb.)	6·62	1·08	2·97	·56	3·72	·24
Na_2O ...	·43	4·09	·45	8·09	·08	·07
K_2O	·38	·10	·26	·03	2·01	·11
MgO	22·49	4·70	24·71	3·36	·70	·06
CaO	·69	9·70	4·06	5·16	·66	·56
MnO	1·38	1·25	·55	...	Trace	...
FeO	7·33	8·35	8·18	1·73	...	...
Fe_2O_3 ...	1·60	·87	...	4·36	3·52	1·70
Al_2O_3 ...	9·99	17·09	9·29	16·03	12·55	20·08
Fe	...	·09	·13	·12	...	...
S	...	·10	·15	·14	...	...
H_2O (Hyg.)	·21	·05	·02	·05	·32	·21
	100·69	99·24	100·19	100·03	100·64	100·40
Sp. Gr. ...	2·08	2·95	2·85	2·73	2·47	2·81

5089.—Schistose Greenstone (talcose). Tower Hill Lease No. 4387. Analyst, C. C. Williams.

5088.—Massive Greenstone. Tower Hill Lease No. 4387. Analyst, C. C. Williams.

5087.—Schistose Greenstone (chloritic). Tower Hill Lease No. 4390. Analyst, C. C. Williams.

5086.—Altered Greenstone. Half-a-mile East of Mount George. Analyst, C. C. Williams.

5099.—Massive Greenstone. Quarter of a mile north of Pride of Leonora mine. Analyst, C. C. Williams.

5084.—Crushed Granite. Near Trigonometrical Station, Leonora. Analyst, C. C. Williams.

Distribution and Character of the Ore Deposits.

With the system of mapping adopted, the ore deposits conveniently fall into four classes, according to the rocks in which they occur, but there is similarity throughout in a lenticular habit, and particularly in the tendency to follow the planes of foliation of the containing rocks. The term "bedded-vein," however, is in no way applicable.

In the granitic rocks to the west there is only one representative in the "Trump" mine; while at the junction of these rocks with the greenstones, where the remarkable masses of quartz ("Quartz Blows") have been developed (Plate IV.), "the Forrest" and "Tower Hill" deposits alone are auriferous, the latter being of very great size.

The "Leonora Gold Blocks," "Sons of Gwalia," and "Gwalia South," with numerous other smaller occurrences, are examples of lodes and reefs wholly in the greenstone; while the "Lady Lena," "Ironstone" (Pride of Leonora), and "Sons of Australia" (Camel leases), are deposits in the granite schists.

There is a great variation in the thickness of the reefs, which in every case consist essentially of quartz: with, in the unoxidised portions, both iron and copper pyrites as associated minerals, the latter being regarded by prospectors as an indication of richer stone.

So far as their permanence at a depth is concerned, the workings, as a rule, have been entirely confined to the oxidised zone above water level; but from the information available, there is no reason to anticipate any failing in this respect, and in the Sons of Gwalia—a somewhat isolated occurrence in this district, however—development is being satisfactorily carried on at a depth of over 1,000 feet.

Of alluvial deposits, there are at most only two examples—that known as the "Specking Patch," at the north-eastern corner of the map, and a small area close to the Forrest mine. With regard to the former, where the workings extend over 30 acres, there is very little information obtainable, except that a good deal of alluvial gold obtained, the largest piece being a nugget of 32ozs.

PLATE IV.

A great number of shafts were sunk through the superficial deposit just to the north of the Forrest mine, and it appears that several of these with the most easterly situation "bottomed" on a deposit precisely similar to the "pug" obtained in the so-called deep lead at Kanowna.[*]

This material was somewhat stratified in appearance, and in some places the joint surfaces showed films of gold, which I have no doubt was of secondary origin and derived from the northerly extension of the Forrest reef.

The Mines.

THE TRUMP MINE.

Lease.	Total Ore.	Total Gold.[†]	Average Grade.
Nos. 268c, 482c	tons. 11,989·35	ozs. 11,296·28	ozs. ·94

[†] To end of 1903.

The leases are situated three miles north-west of Leonora, adjacent to the Lawlers Road on the western side, and the discovery of gold thereon, one of the first finds in the district, was made by Messrs. Collins, Armstrong, and Roach, in 1896. Some remarkably rich ore was obtained near the surface, the first parcels being crushed at Menzies, and a syndicate, comprising most of the original prospectors, at present own the property.

The deposit is interesting, both from its form and position, as it is the only payable one which has so far been found to the west of the Greenstone.

The strike of the outcropping portion of the vein is 66 degrees east of north, and the average dip about 12 degrees to the south; but farther from the surface, just above the water level, there is evidence of a steeper dip.

The prominent feature in the mine consists of a main quartz vein following the planes of foliation of the crushed granitic rock, which has been squeezed up, and a system of joints developed in the form of an anticline. Though the deposit generally follows one of the main partings of the rock, occasionally a portion has taken an upward course and finally followed a parallel parting above, so that the workings are very irregular, and it is difficult, without the aid of a plan, to trace its general course.

An outcrop is visible for a short distance to the east, but no trace of the reef could ever be found near the surface to the west of the main underlay shaft.

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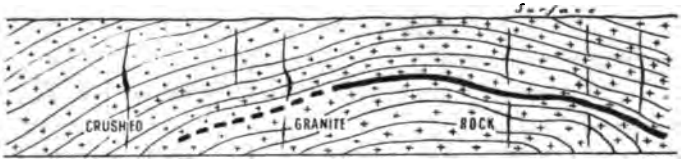
[*] Report on the so-called deep lead at Kanowna, Bulletin No. 3 of the Geological Survey of W.A., pp. 31, 32. T. Blatchford. Perth: By Authority. 1899.

The reason for this is evident on an examination of the workings, which also leads to the conclusion that the vein is in the form of a saddle, the axis of which has an east and west direction, and a slight dip to the west. At 250 feet, in the shaft, a long drive to the west, beginning with a slight upward incline, follows the vein, which at first had a southerly dip, but becoming quite flat and then assuming a northerly dip, there is a considerable fall to the end of the drive; which has thus passed over the cap of the saddle about 30 feet below the surface (Fig. 2).

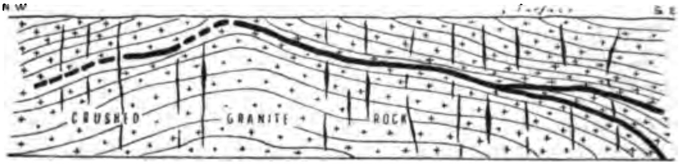
Fig. 2.



SECTION OF REEF ABOUT 2½ CHAINS S.W. OF MAIN SHAFT, TRUMP MINE.

The anticlinal tendency can be well seen on examining the rocks near the working shaft, and in an old shaft just to the north the reef appears to have been cut at a depth of 23 feet, lying in an almost horizontal position (Fig. 3).

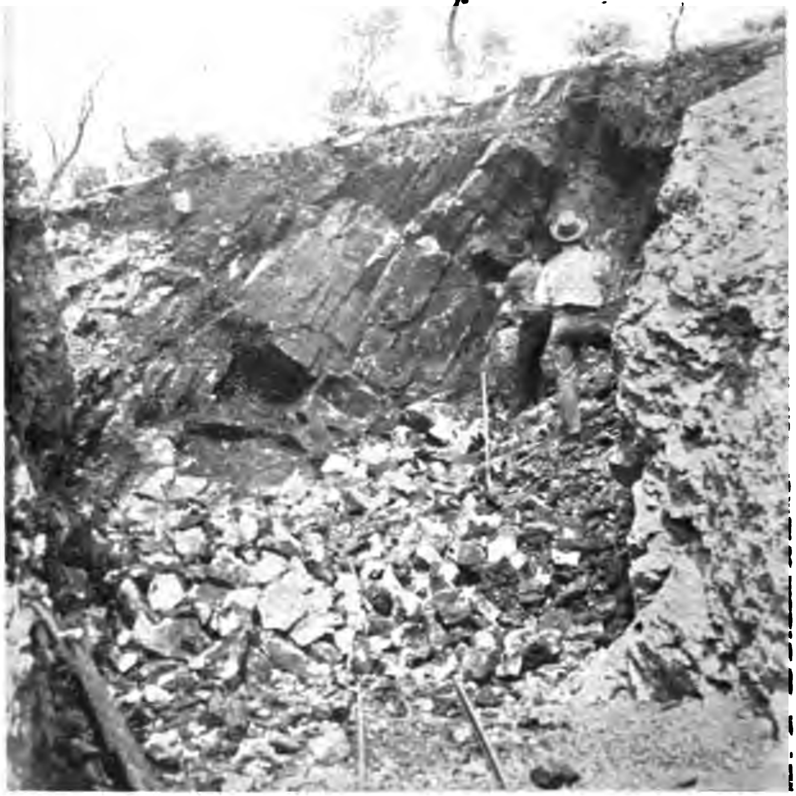
Fig. 3.



SECTION OF REEF AT MAIN SHAFT — TRUMP MINE

As well as these indications pointing to the existence of a northern leg, the formation of the deposit in a fissure, which owes its shape to the contortions which the gneissic rocks have undergone, suggests the possibility of an arrangement similar to that of the ore bodies in true saddle reefs. Prospecting operations, so far, have been chiefly directed towards testing the continuation to the south of the main vein already worked.

In this respect it may be mentioned that a water shaft about 200 feet south of the outcrop, after passing through the main vein at 14 feet, cut at 50 feet a small gold-bearing vein apparently dipping in the same direction and at a greater angle (65°). In addition to shafts, three diamond drill bores were put down at a



Open cut showing Hanging Wall of Lens and character of Quartz, Tower Hill.

mean distance of about 15 chains to the south, but the particulars and results regarding them are only known to Messrs. Bewick, Moreing, & Co., by whom the work was undertaken.

Besides those following the foliation of the rock, there is a system of vertical or highly inclined veins, with a similar east and west strike; but apparently they do not carry payable gold, as they have in no case been removed.

Work has been carried on from an underlay shaft following the deposit for 400 feet, and at 240 feet the main vein is divided by a "horse" of less crushed granite; the lower arm having been followed and worked. Levels have been driven to the east at distances of 100 feet, 250 feet, and 300 feet, and to the west at 100 feet, 250 feet, and 270 feet, the bulk of the stoping being on the east. Development work, however, is now chiefly on the western side of the shaft, and has, up to the present, been entirely confined to the portion of the deposit above water level.

The main quartz vein, which is sometimes several feet in thickness, is flanked by smaller strings and veins, and the ore obtained contains a good deal of decomposed rock, which carries gold, probably in the filling of the joints. This associated rock has a noticeably bad effect on amalgamation, and an examination by the Departmental Mineralogist of a sample of the ore [5232], taken from the battery floor, showed it to contain, in addition to the ordinary constituents of a granite, the minerals pyromorphite (phosphate of lead) and mimetite (arsenate of lead); to which, as well as the large proportion of kaolin present, the interference with the process is due.

THE TOWER HILL.

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 218c, 219c	tons. 3,597	ozs. 1,192·05	ozs. 0·33

*To end of 1903.

The Leases, which were taken up early in 1897 by a prospector named Breen, are situated one and a-quarter miles south of Leonora, just to the west of the railway line, and are at present the property of the "Octagon Explorers, Ltd.," by whom nearly the whole of the prospecting work has been done.

There are several remarkable features about the deposit, which forms the best example of the occasionally auriferous nature of the quartz masses in the district.

A reference to the map will show the position of the principal quartz bodies. They are generally in the greenstone schists almost at their contact with the granite, but instances occur in which they are situated wholly in the latter rocks.

Throughout them all there seems to be a strong tendency to a lens-shaped plan, but there is not much information, to a greater depth than 500 feet, bearing on the question of their form in a vertical section.

All in the vicinity of Tower Hill are said to carry gold, but the operations of the syndicate have been chiefly confined to those at the north end, which are so closely associated as almost to form one continuous deposit, with an average strike in a north and south direction and a dip to the East of 45 degrees, similar to that of the schists.

Fig. 1, Plate VII., shows the position and the relation to the granite and greenstone of the deposit worked by the Tower Hill Company, which is by far the largest of any, and attains a width of 80 feet measured horizontally in the deepest crosscut.

The whole width, moreover, is composed of white quartz, which shows signs of crushing, and consists of a series of more or less solid portions running in distinct bands, with the space between filled with a more broken variety, there being a rough system of parting planes, along which it is broken down in blocks. (Plate V.)

There is scarcely, if any, associated rock, except at the outside near the hanging wall, where thin laminæ of schist are found in the quartz, some of the surfaces showing signs of slikensiding and thin scales of gold.

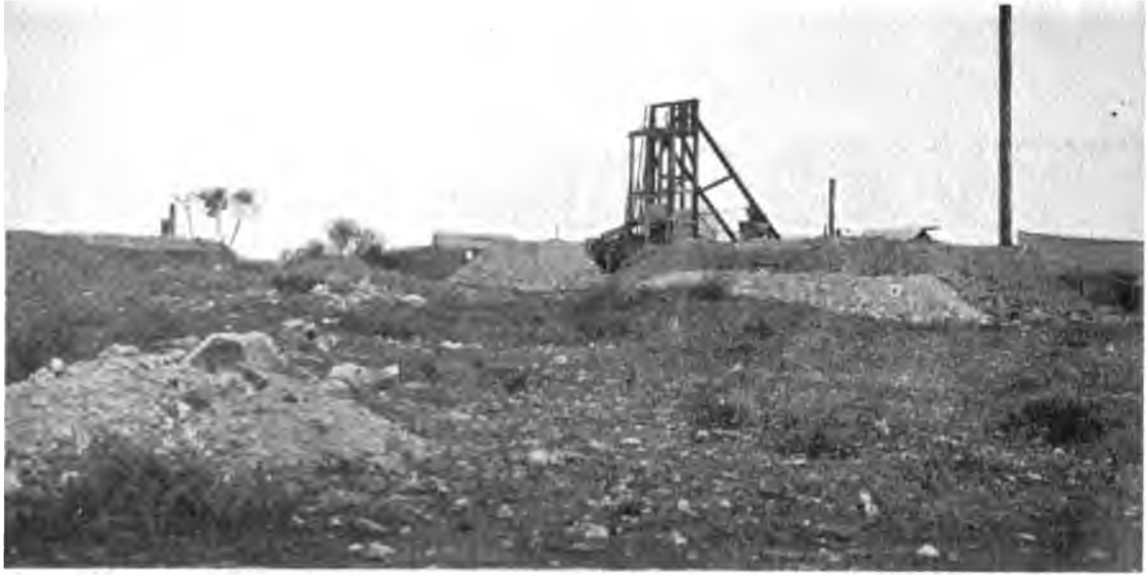
Some of the quartz lenses or "blows" contain areas of quartz and dolomite, the latter being ferriferous, which gives it a red colour; and there are also traces of copper carbonates, though not in the main deposit, where the whole of the gold is in an amalgamable form.

The first work of the prospectors was a large open cut, but subsequently shafts were put down to about 75 feet (water level), and the quartz explored by a system of drives. (Fig. 3, Plate VII.)

The quantity and value of the ore obtained have already been stated; but as regards the distribution of the gold in the deposit, the question is a difficult one to decide. Some information relative to its continuance has been obtained by a bore put down on the eastern side, which cut the hanging wall of the quartz at a depth of 366 feet 6 inches, and passed through the footwall at 501 feet 6 inches.

It appears that at this point the gold was not evenly distributed, but chiefly occupied more or less definite positions in the upper half and lower half of the quartz body. Further than this there is no evidence bearing on the question.

A reference to the map will indicate the numerous other quartz masses, the only similar deposit of importance being that known as the Forrest.



Leonora Main Reefs, showing Outcrop and Workings.

THE FORREST.

(*Leonora Main Reefs.*)

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 210c, 253c	tons. 843	ozs. 1,297·58†	ozs. 1·46

* To end of 1903. † Includes 66·25 ounces from specimens.

The leases are situated two miles north-west of Leonora, and about a quarter of a mile west of the Lawlers road.

The reef was discovered by Messrs. Smith and others during 1896, and these original prospectors obtained most of the gold which the mine has yielded; the ore being crushed at the North Star battery, Mount Malcolm. They worked to a depth of about 60 feet, when the rather large supply of water put an end to their operations. The property then passed into the possession of a Perth Syndicate, finally the Leonora Main Reefs Company.

The deposit which has also a north and south course, but is almost vertical or with a slight tendency to a westerly dip, is of similar type to that of the Tower Hill, though rather more of the nature of a large quartz "reef."

It occurs in the same manner almost at the junction of the greenstones and granitic rocks; in fact, passes from one to the other, the reef at the south end being wholly in the granite; while in the vicinity of the workings in the greenstone, and in some places follows the junction.

In addition to a large reef more or less centrally situated, there are others of smaller size and what would seem to be detached masses; but satisfactory information with regard to the form and extent of the deposit cannot be obtained in the old workings, where the rocks are much broken and decomposed.

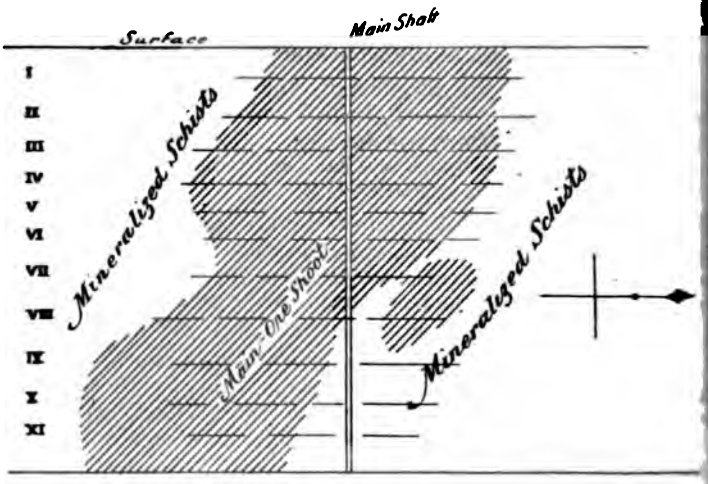
The present owners found it necessary to sink a new vertical shaft at the north end and just to the west of the outcrop, but owing to a temporary cessation of operations the water was allowed to accumulate, and the new workings were inaccessible. (Plate VI.)

From the bottom of this shaft, which was sunk to 155 feet, the reef was intersected by a crosscut 27 feet east, and has been explored by drives to a small extent at that level. When sinking was discontinued, the shaft was still in the greenstone schists.

In the early stages of the mine some remarkable specimens of gold in quartz were obtained, especially from Lease 210c, and these were secured by the West Australian Government for the Paris Exhibition.

As a greater depth was reached the shoot was found to have decided trend to the south, and the northern end, advancing at th rate of about 60 feet per "level," passed to the south of the sha at about the No. 6 level, a habit which has been most consiste (Fig. 4.)

FIG. 4.



PLAN SHEWING SOUTHERLY TREND OF MAIN ORE SHOOT, SONS OF GWALIA.

In the annual report of the directors of the company for 190 the ore reserves in this shoot are given at 133,417 tons, and in th "B" shoot 9,071 tons, a total of 142,488; which, in June, 190 had been increased to 188,623 tons, of average grade.

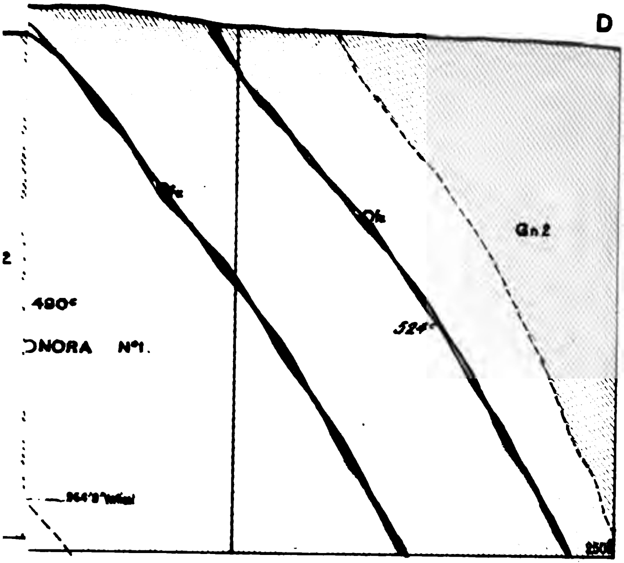
The deposit is worked from a main inclined shaft by mean levels driven roughly at intervals of 100 feet, the lowest at pres being the No. 12, at a vertical depth of 1,056 feet.

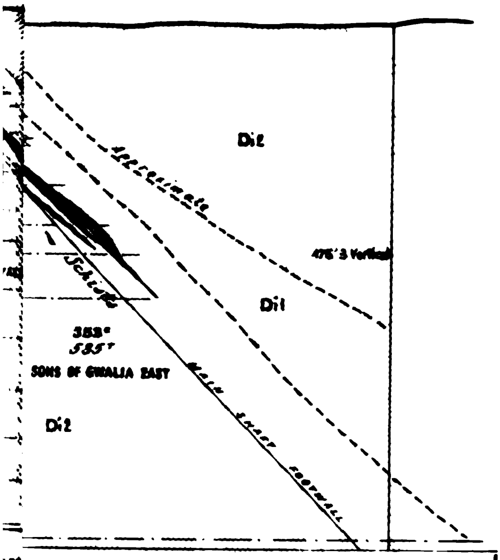
The upper portion of the shaft approximately followed th main shoot, but owing to the somewhat flatter dip at a greate depth that ore body is now considerably to the east; and a mai crosscut from the shaft is necessary to intercept it. The crosscut are continued east until what is termed an "indicator vein" is me with—a small vein or string of quartz containing values, an apparently connected with the main shoot—and this is followe towards the south until the drive is carried into the main ore lens.

In order to save driving in the three lower levels a south easterly direction has been given to the main crosscuts immediatel on leaving the shaft.

The upper levels have been driven to the apparent limits of th ore, both to the north and south, but no very extended prospectin appears to have been done in search of an extension of the depos or the existence of another shoot, which, towards the north, is stil

BULLETIN No 13 PLATE VII.





150f NORTH OF SONS OF GWALIA SHAFT

A. Gibb Maitland
Government Geologist

a matter of conjecture, though some light is afforded on the question of an extension of the lode southwards by an examination of the workings of the Gwalia South Mine. (Fig. 2, Plate VII.)

What appears without doubt to be a continuation of the Sons of Gwalia lode is being worked at a depth of about 187 feet; which would be at a level between the No. 2 and No. 3 in the Sons of Gwalia mine. At this point the shoot is considerably farther west than would have been expected, and has, moreover, assumed a course somewhat more east of north. There is also another small shoot about 80 or 90 feet east, the course of which, as far as can be judged from the workings, trends even more to the eastward; and if it continued thus would pass at this level into leases 380c and 353c. The ore bodies can only be examined in one place, however, and the surface is covered by the tailings dump and slimes pits. (Plate VIII.)

The ore, even in the most quartzose portions, has a crushed appearance, and portions of it separate along parting planes in which are thin laminæ of chloritic schistose material, often showing thin gold on the surfaces. An examination of samples by Mr. E. S. Simpson, the Departmental Mineralogist, has shown that in addition to the predominating quartz and pyrites, calcite chlorite muscovite and acicular tourmaline are present as associated minerals.

When passed through the mill, the resulting pulp from which about 65* per cent. of the gold is obtained by amalgamation, contains 53* per cent. of sands, 45* per cent. of slimes, and 2* per cent. of concentrates. The concentrates are reserved for separate treatment.

The sands and slimes, after leaving the concentrators, are elevated to spitzkasten, which returns to the machines a certain per cent. of coarse sands and concentrates; the remainder passing to the collecting vats, the slimes through slat-grates to the settling dam.

The sands collected in the vats, after being treated with a preliminary wash, are dumped into other vats beneath, and given appropriate cyanide treatment. The concentrates collected from the tables are ground in wheeler pans, and pass thence to agitators, when, after filter-pressing the resulting product of agitation with cyanide solution, a good extraction is said to be obtained, or, summing the various processes, a total extraction of 85* per cent.

The ore is mined and thus dealt with by 50 stamps, with a duty of 5·5 tons, and at a cost to the company of £1 0s. 7d.* per ton.

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* Figures supplied by manager, August, 1903.

THE EASTERN
(*Gwalia South*).

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 198c	302	363·17	1·20

* To end of 1903.

The lease is situated immediately to the south of the Sons of Gwalia, No. 190c, and adjoining it.

The outcrop was discovered shortly after the Sons of Gwalia by a prospector named Duffil, and a lease taken up, which, however, was chiefly under exemption or only worked intermittently until the end of 1902, when the present company was formed in Melbourne.

The deposit is situated in the schists, in a precisely similar manner to the Sons of Gwalia, of which, as already explained, it is no doubt an extension; and is limited in width on the east by a similar mass of greenstone, also, probably, a continuation of that already mentioned.

The character of the lode formation and the ore are also identical, the latter being sent for treatment at the public battery.

The development work on the lode amounts to 207 feet of sinking, shaft and winze, and about 116 feet each of crosscutting and driving, the deepest level being at 187 feet.

The workings are situated 236 feet from the boundary, so that, if the lode continues at its present dip to the east, it will, as a depth is reached, pass out of the lease into the Sons of Gwalia Extended, Nos. 584 and 380, held by the Sons of Gwalia Company.

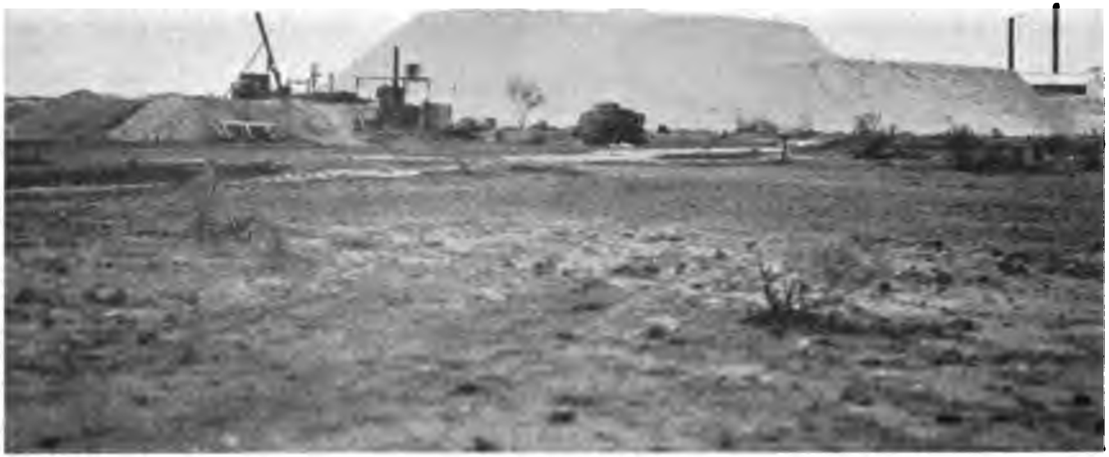
So far, however, it has only been explored at the northern end of the lease, which is 12 chains square.

Farther south, a considerable amount of prospecting has been done in search of a continuation of this lode, and leases were taken up and shafts sunk for more than two miles; but no work has been done for some years, and it is difficult to collect facts, either with regard to the extent of the operations or the success met with.

It is advisable, however, in a report of this kind, to record the information obtained, and most interest attaches to the leases known as the "Star of Gwalia" and "Star of Gwalia South":—

THE STAR OF GWALIA AND STAR OF GWALIA SOUTH (LEASES Nos. 478c, 479c).

These leases are situated half-a-mile almost due south of the Sons of Gwalia, and were taken up and prospected, I believe, by Mr. G. W. Hall. It is said that, both by sinking and with the aid



The Gwalia South Mine working the Southerly Extension of the Sons of Gwalia Lode, showing relative position of two Mines.

of diamond drills, the country was explored to a depth of at least 1,500 feet, and in the Star of Gwalia there were crosscuts at water level from the east to the west boundary of the lease, without success as far as the Gwalia lode was concerned, or indeed a payable formation.

What has no doubt been the deepest shaft, on Lease 479c, appears to have been sunk on the same zone of massive rock met with in the workings to the east of the Sons of Gwalia lode, which it entered at a depth; and while it is not surprising that the shallower shafts did not intercept the lode, if it exists, it appears most probable that the deeper efforts were mis-directed by an expectation of finding it considerably farther east than might now be expected: a supposition to which the evidence from its appearance in the Gwalia South mine strongly points.

Immediately to the north of the Sons of Gwalia there have also been a number of leases taken up and shafts sunk in the greenstone schists, of which, however, but little information is obtainable.

THE ROCHESTER (LEASE No. 450c).

This lease is situated 36 chains north of No. 190c, and a shaft was sunk by an Adelaide company, I believe, to a depth of 300 feet, but without any result. It is now held by the Sons of Gwalia Company, and used by them as a water supply shaft.

North of the townsite of Leonora are further deposits in the greenstone, some of which, like those of lesser importance to the south, are only worked intermittently or abandoned.

THE SAVANAH.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 621c, 786c, etc. ...	121	85·98	0·71

* To end of 1903.

No. 621c and the original leases, 786c, 787c (now voided), are situated about 75 chains north-west of Leonora, on the eastern side of the Lawlers Road.

There are shallow shafts and workings for more than a mile along the line of reef, but work has never been more than superficial and intermittent.

The deposit occurs in the greenstone schists, with a corresponding strike of 32 degrees west of north, the dip of 70 degrees being to the east. It is not very large, its chief characteristic being in the ore, a highly ferruginous banded quartz, which has already been mentioned in connection with its relation to the larger masses of similar variety.

THE GREAT BOSTON.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 546c	279	113·45	0·40

* To end of 1903.

This lease is situated a mile north-west of Leonora, on the western side of the Lawlers Road. It has been abandoned for some years, so that little information with regard to it can now be obtained.

There appears to have been a deposit of the character of a "lode formation," and some extensive development work was undertaken by Mr. G. W. Hall, especially at the 120 feet level, where some long crosscuts were put in; but considerable quantities of water were met with, and the gold yield shows that the ore obtained was of low grade.

The option held by Mr. Hall was abandoned, and no further work has since been done. The lease is now held by the Sons of Gwalia Company as a reserve water area.

THE COMMONWEALTH.

(*Grey Lode.*)

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 954c (711c) (556c) ...	199	85·60	0·37

* To end of 1903.

These leases and others have been taken up and forfeited at different times, enclosing the same area, but with corner pegs in slightly altered positions.

No. 954c, now known as the Commonwealth, is situated one and a-half miles north-west of Leonora, and the deposit, which was one of the first worked in the district, has received only occasional attention from different prospectors.

The reef is in the greenstone schists, having a strike about 9° west of north, and an average easterly dip of 35°. The quartz composing it has a greyish colour, and varies from one to four feet in thickness, with a considerable proportion of sulphides even near the surface.

An underlay shaft follows the reef for about 40 feet, in which distance it appears to be faulted in two places, and the eastern portion dropped about 10 feet. There are, besides, several vertical shafts sunk on the back of the reef, and the prospectors working there at present intend to sink another to intercept it at a rather shallower depth.

The Leonora Gold Blocks.

Lease.	Total Ore.	Total Gold.*	Average Grade.
Nos. 195c, 196c	tons. 6,144	ozs. 9,740·53	ozs. 1·58

* To end of 1906.

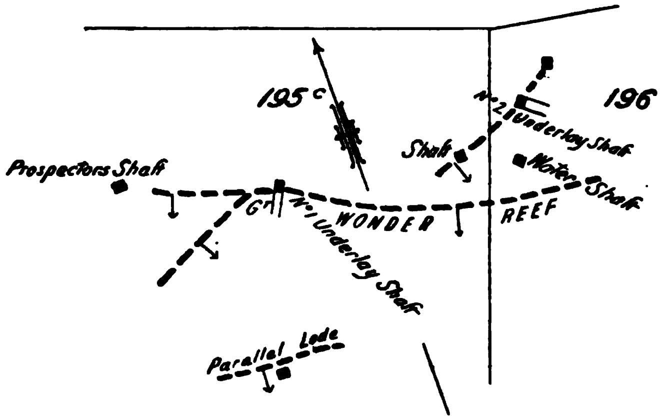
The leases are situated just to the east of the Lawlers Road, four miles north-west of Leonora, and the deposit was one of the first discovered in the district, in 1896.

Lease 195c was taken up on the 3rd June, 1896, by a prospector named McPhie, an employee of a Perth syndicate, who are the present owners of the property.

Only one or two small pieces of quartz were found near the outcrop, the actual discovery of which is attributed to a black boy attached to McPhie's party; and the reef was afterwards located beneath the cement.

Two main reefs have been opened up, situated in an area of massive and crushed greenstone, and on Leases 195c and 196c (Fig. 5).

Fig. 5.



PLAN SHEWING POSITION OF PRINCIPAL REEFS LEONORA GOLD BLOCKS.

That situated on Lease 195c, originally known as the Great Wonder, was worked from the No. 1 underlay shaft, and has a mean strike of about 10 degrees south of east, but there are several curves and branches.

As exposed in the shaft, the deposit consists of a quartz vein, centrally situated in a zone of crushed greenstone, which contains smaller parallel quartz veins; and the whole formation, which dips at 55 degrees to the south-west, is enclosed by almost parallel walls of massive greenstone.

The zone of crushed rock, with a width in one part of the shaft of about two feet and in many parts of the workings considerably more, is decomposed and mineralised.

The character of the reef on Lease 196c, which is being worked at present from No. 2 underlay shaft, is somewhat similar, except that the containing rocks are completely foliated. Its approximate strike is about 15 degrees north of east, the dip from 25 degrees to 30 degrees to the south of east; the main quartz vein and the accompanying formation have a payable width of from one to three feet.

Its form, however, is very irregular, and being interfoliated with the greenstone it follows the contortions of the rock, and not unfrequently splits up into two portions, which for some distance follow different parting planes. Often a kind of saddle is formed, and in such cases the upward and downward legs are generally found to be rich, while the ridge or cap is impoverished. When the deposit splits in this manner, it is sometimes difficult to know until some work has been done which is the branch and which the main vein, as the former sometimes contain high values.

Passing through the workings are two felsite dykes, which can be traced on the surface with a parallel course from the south-east to the north-west corner of the lease, and have a width of from 15 to 20 feet.

Known as "white lodes," they dip to the east at about 60 degrees, their strike being almost at right angles to the direction of foliation of the greenstone.

The continuity of the reef, however, is not broken, and at the intersection the felsitic rock is said to be mineralised and auriferous for a small distance on either side of the vein.

Outcrops of similar rock are to be seen on the surface to the south and the north, but it is not possible to trace them for any great distance, owing to the prevailing superficial deposits. While the general characteristics are those of a dyke, and the rock slice of the least decomposed specimen obtainable has the appearance of a felsite, the subject cannot be left without reference to the innumerable metamorphosed varieties of the greenstones found elsewhere, one form somewhat similar to the rock in question, and to which a connection might possibly be traced when further information is obtainable.

Quite recently another reef carrying gold was discovered and a lease taken up just to the south of the Leonora Gold Blocks, and in addition to the two already mentioned there is another reef on

Lease 195c, known as the "parallel lode," from its approximately similar course to that of the Great Wonder. The dip is also in the same direction, but the vein is highly inclined and the outcrop is about four chains west of the No. 1 underlay shaft.

Messrs. Bewick, Moreing, & Co. commenced the work of sinking a diamond drill bore to the west of this outcrop, the intention apparently being to intercept both this reef and the Great Wonder; but there is no information obtainable either with regard to the results obtained or as to whether the intention was ever completely carried out.

There has been a considerable amount of development work, especially from the No. 1 underlay, which follows the dip of the vein for 150 feet, and from which levels have been opened out both east and west at 50 feet, 95 feet, and 150 feet; in all about 1,300 feet of driving.

Development from the No. 2 underlay shaft is being chiefly carried on at a level corresponding to the upper one on Lease 195, the intention being to connect the two and ascertain whether the reef is a branch of the main reef. A number of shafts have been put down by prospectors at the north-west corner of Lease 195, in search of a continuation of the Great Wonder, but without success, the majority of them being sunk in the granitic rocks to the west.

So far the ore, nearly all obtained from the oxidised zone, has been amenable to treatment without special appliances; but, at a greater depth, it appears that its character will be that of a sulphide ore. The bulk of that obtained has been dealt with at the mine by a 10-stamp battery, working at present with a duty of 2·7 tons, and there is a small cyanide plant attached.

The Clarence.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
Nos. 908c (731c) (465c) ...	314·75	521·49	1·65

* To end of 1903.

The leases are situated five miles north-west of Leonora, and about half-a-mile from the Lawlers Road, on the east side. The original prospectors of the claim, in 1897, were Messrs. Adams, Ferry, and Boatright, by whom it was abandoned, and shortly afterwards a considerable amount of gold was obtained by other prospectors.

There are three veins or reefs, having an approximate parallel strike of 52 degrees east of north, and a southerly dip varying from 45 degrees to 85 degrees. The rock in which they occur is in the upper portions decomposed and completely converted into a clay, which in places shows evidence of an original schistose structure and has no doubt been derived from a basic rock.

The centrally situated of the three veins is that on which the most work has been done, and there are a number of shallow shafts and surface workings along the outcrop; but the bulk of the prospecting was done from a vertical shaft which cuts the reef at a depth of 60 feet, just above water level. The vein has a lenticular habit; and the ore, essentially a quartz, shows often a good deal of free gold.

The second parallel vein of the same character which has been recently opened up is about 50 feet south, and though small, has returned good results.

THE RICHMOND.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 780c	124	137·31	1·10

* To end of 1906.

This lease is situated just to the west of the Clarence, and almost adjoining it; five miles north-west of Leonora.

The deposit, which is of similar character, was discovered in 1897 by Messrs. Ferry and Pain, and has also a strike of 25 degrees east of north and a southerly dip of 65 degrees.

The prospectors sunk a shaft to a depth of about 65 feet, and stoped all the payable ore they could find above water level.

CLIFTON HILL.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 689c	104	76·62	0·73

* To end of 1906.

The lease is situated half-a-mile east of the Clarence, five miles north-west of Leonora.

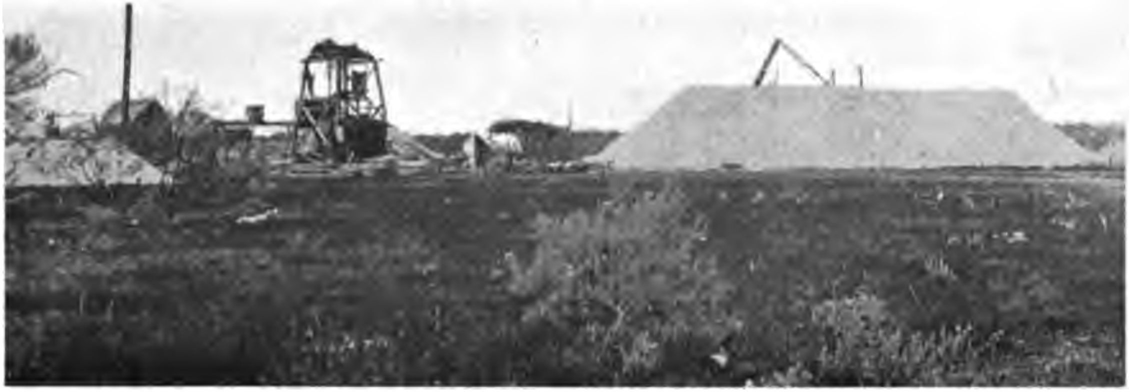
There are two quartz veins in the foliated greenstone with a strike of about 45 degrees and 10 degrees west of north respectively, and an average underlay to the east. They were discovered by a prospector named Vetter, and have been worked intermittently by shallow shafts along the outcrop.

PRIDE OF LEONORA.

(*Ironstone.*)

Lease.	Total Ore.	Total Gold.	Average Grade.
	tons.	ozs.	ozs.
No. 618c	1,213	1,152·86	0·95

* To end of 1906.



The "Ironstone" Mine, showing white kaolin and surface covered with clay ironstone.

The lease is situated four miles north-east of Leonora, and the original discoverers of gold at the spot in 1898 were Messrs. Goodall and Williams. The property is now locally owned and worked.

The deposit is in the granitic schists, and is the most important of those which have been classed as a fourth and separate series in the district; having many features of interest, but on the whole not as productive as others described.

The rock containing them—originally a micaceous schist as already stated—contained, as well as plagioclase felspars which are so much more subject to kaolinisation than the potash varieties, an iron-bearing mineral in the form chiefly of white mica; and the anhydrous or lower-hydrated mica becoming hydrated, with at the same time an increase of bulk, has been a factor tending to a rapid weathering.

Decomposition has extended to a very great depth, and the rock become converted into a white kaolin-like clay. The process, moreover, taking place with an insufficient supply of oxygen, has further resulted in a solution of certain of the ferriferous salts; which in the joints and vein-fissures, and where a small supply of oxygen might be met with, have been re-deposited in the form of an insoluble sesquioxide, thus producing the characteristic brown coating of the quartz veins in the formation, and ultimately giving rise to the large quantities of ferruginous clay ironstone referred to already on the surface (Plate IX.).

The main vein on lease No. 618, with a strike of 23 degrees west of north, has an easterly dip of 50 degrees; and has with the accompanying ferruginous matter been stoped in many places for a considerable thickness.

The prospectors worked by shafts chiefly on the outcrop, but it is the present intention to intercept the vein by a vertical shaft, which has now been sunk to a depth of 180 feet; and in the material obtained from the bottom of this shaft, though some of the white mica is still showing white and intact, an original schistose structure is only just apparent.

This is the deepest sinking yet undertaken in the formation, hitherto only prospected above water level, and further developments will no doubt furnish many results important in connection with the value of the deposits generally.

About 10 chains to the west is a small vein which is being opened up on lease No. 850c., and this, though smaller and the quartz less ferruginous, is similar in most of its characteristics to that at the Pride of Leonora, the containing rock being similarly decomposed.

ASHLEY'S UNITED.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 679c	343	421·61	1·23

* To end of 1903.

The lease is situated 4½ miles east-north-east of Leonora, and was originally known as "Ashley's Find." The deposit was discovered shortly after the Forrest reef by some of the original prospectors.

The gold from Ashley's United has been obtained from two quartz reefs which have a strike in an east and west direction; the dip being at a fairly high angle to the north; and these veins are supposed, by prospectors working there at present, to be leaders from a main reef lying to the west. There is a highly ferruginous mass outcropping to the west, which contains quartz, and shows gold by dollying even in the ferruginous portion, but in that case it is generally a film on the parting surfaces.

The quartz veins vary from three inches to 18 inches in thickness; and with the surrounding iron oxide and clay ironstone, which also contains gold, have formed an ore body of much greater width, which has been stoped in places from water level to the surface—about 60 feet.

Just to the east of Ashley's United is a group of old leases which were, no doubt, taken up on account of the alluvial deposit, the "Specking Patch" already referred to (page 20). Several shafts were sunk, and I believe a little gold obtained from some small quartz veins with a north and south strike and an easterly dip.

In connection with the deposits in the granitic schists, a lease situated about 1½ miles north-west of the Ironstone and outside the area of the map cannot be overlooked.

THE SONS OF AUSTRALIA.

Camel Leases.

Lease.	Total Ore.	Total Gold.*	Average Grade.
	tons.	ozs.	ozs.
No. 914c (526c)	680·50	962·72	1·41

* To end of 1903.

The prospectors most identified with the Sons of Australia were Hurkett and party, who sank several shafts, one at least to a depth of more than 100 feet. The deposit is in a similar formation that at the Pride of Leonora and Ashley's United.

LEASES OF MINOR IMPORTANCE.

Voided Leases and Sundry Claims.

In addition to those referred to in detail, there are a great number of other leases which have no geological importance, in that they present no structural features of especial note, and which, in fact, have only an interest in so far as they have added a small increment to the total production of the district. The particulars of each are tabulated hereunder.

The total production of all leases in the Leonora district has already been stated in the opening paragraphs of that portion of the report referring specially thereto.

PRODUCTION OF LEASES OF MINOR IMPORTANCE.

	Lease No.	Total Gold. [a]	Average Grade.
		ozs.	ozs.
All Nations	886c	33·50	0·56
British Legation	795c	7·75	1·10
Clean Sweep	820c	17·55	5·85
Comet	522c	66·54	1·41
Croydon	585c	51·26	0·28
Easter Gift	769c	2·65	0·18
Fitzgerald's Amalgamated	708c	9·15	0·18
Flanders	562c	10·40	0·44
Grey Lode	704c	19·09	0·29
Gwalia Gem	558c	42·26	0·52
Kruger Steyn	796c	85·75 [b]	...
Lady Lena	503c	37·40	1·55
Lady Lena North	520c	44·08	1·27
Lady Muriel	984c	59·30	0·28
Last Chance	990c	6·57	0·15
Little Dorothy	992c	43·91	1·16
Mt. George Battery	92/5c	2,175·43 [c]	0·82
New Year's Surprise	826c	93·25 [d]	3·29
North Riviera	818c	6·00	0·60
Ottawa	771c	14·75	0·52
Otterburn	354c	2·16	0·86
Pride of Leonora North	649c	6·45	0·35
Royal Flush	931c	116·64 [e]	3·18
Riviera	802c	157·29 [f]	1·17
Rajah	455c	36·95	1·98
Reliance	589c	97·33	0·53
St. Helliers	952c	16·95	0·80
Scallywag	577c	3·00	0·50
Sheffield	725c	37·85	2·32
Supreme	772c	5·05	0·42
Turn of Tide	625c	3·89	0·35
Victor	835c	307·48 [g]	1·27
Warragamba	1008c	36·95	0·53
Westralian Broken Hill	1006c	8·02	0·22
Wyangle	627c	4·56	0·36
Sundry Claims	...	1,484·44	...

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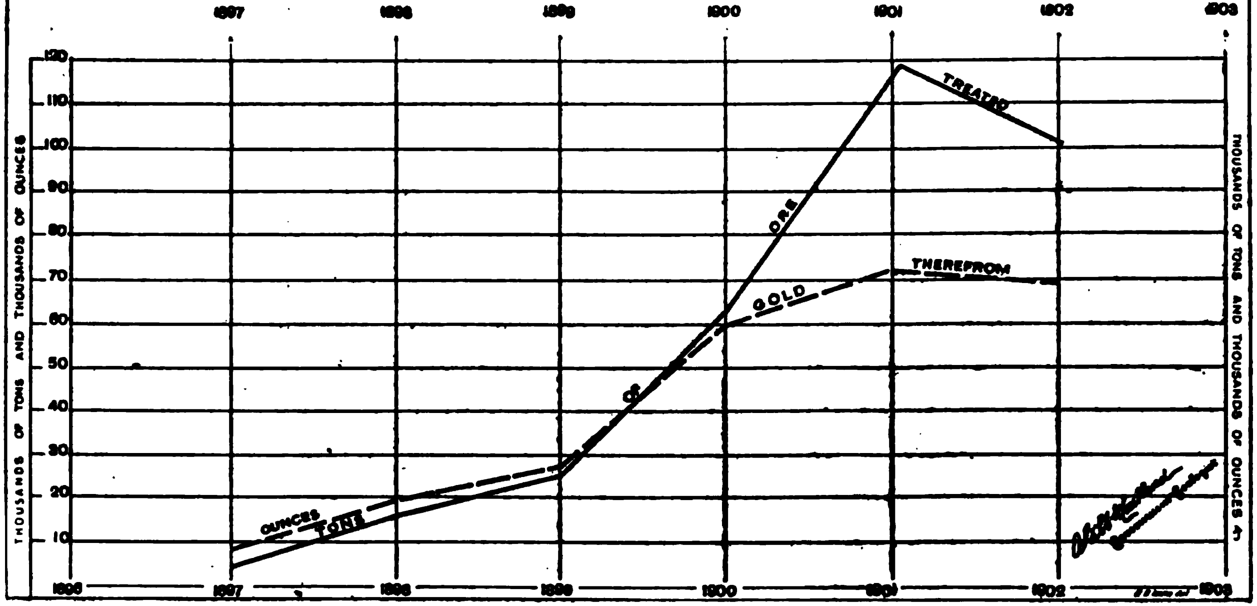
[a] To end of 1903. [b] Includes 11ozs. from specimens. [c] Includes 25ozs. from specimens. [d] Includes 1oz. from specimens. [e] Includes 78·44ozs. from specimens. [f] Includes 115·19ozs. from specimens. [g] Includes 225·34ozs. from specimens.

APPENDIX I

LEONORA DISTRICT

ORE VALUE DIAGRAM

Shewing N° of Tons of Ore treated and N° of Ounces of Gold obtained therefrom for each year since 1897



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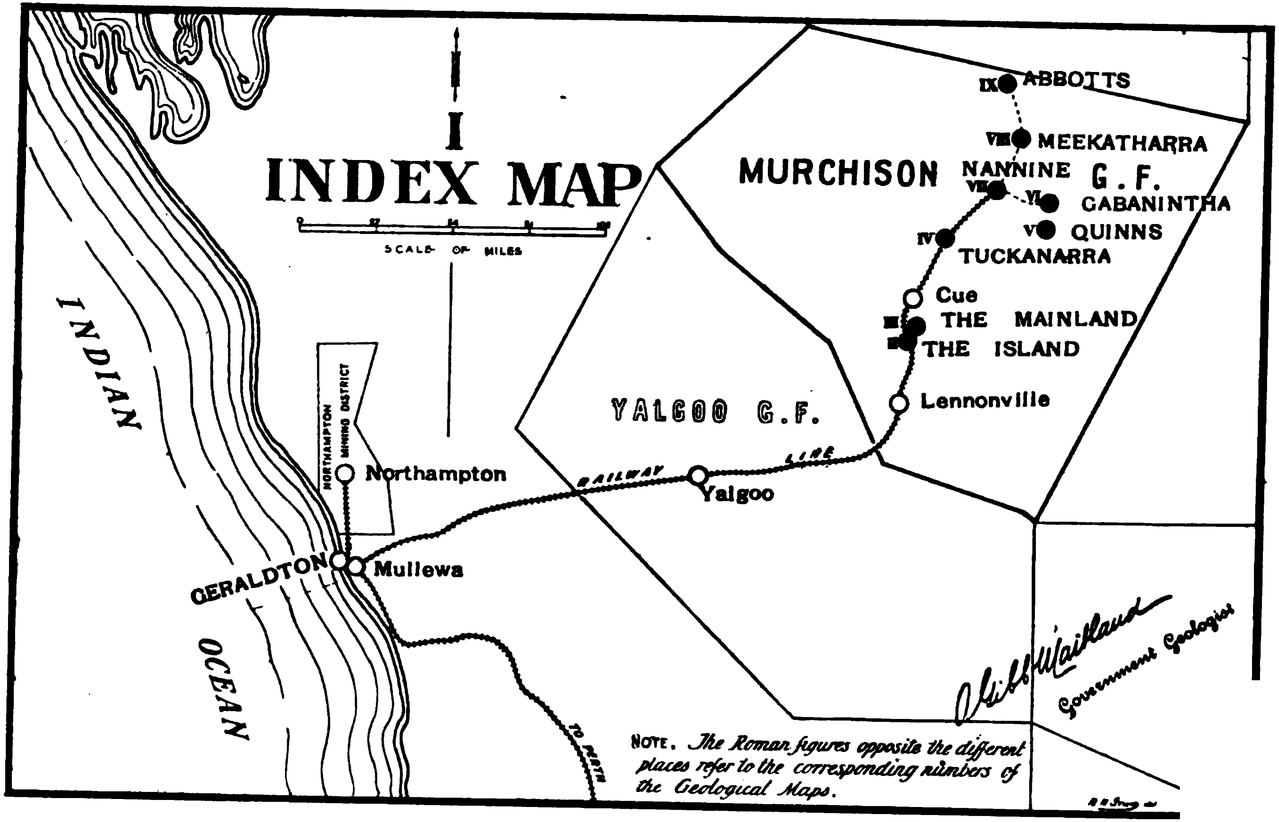
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A. Gibb Maitland
Government Geologist

1904.

WESTERN AUSTRALIA.

GEOLOGICAL SURVEY.

BULLETIN No. 14.

The Geology and Mineral Resources of a part of the MURCHISON GOLDFIELD,

BY

CHAS. G. GIBSON, B.E.,
ASSISTANT GOVERNMENT GEOLOGIST.

Issued under the authority of the Hon. H. Gregory, M.L.A.,
Minister for Mines.

WITH NINE MAPS AND EIGHT FIGURES.

PERTH:
BY AUTHORITY: WM. ALFRED WATSON, GOVERNMENT PRINTER.
1904.

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PREFATORY NOTE.

IT was considered desirable, in view of the light conferred by the results of the Geological Survey of Lennonville, Mount Magnet, and Boogardie, carried out in 1903, that the northern extension of the Murchison Auriferous Series, in the direction of Abbotts, should be undertaken.

The report and accompanying maps represent the results of Mr. Gibson's investigations in this northern portion of the Murchison, and include descriptions of the mining centres of Lake Austin, Tuckanarra, Quinns, Gabanintha, Star of the East, Nannine, Meekatharra, Abbotts, and the Wilgie Mia, Weld Range, in addition to a short account of the country traversed between the different localities.

The field work upon which Mr. Gibson's observations are based was commenced on the 24th of August and completed on the 12th of December, with but a short interruption, when it was found necessary for him to return to Perth for about a fortnight.

The Murchison is of some historical interest in that, in the year 1855, when the economic value of the district as regards its mineral resources was entirely prospective, it was officially set forth in a report to the Government that the country to the east of the Murchison River had every appearance of being one of the finest goldfields in the world. While it cannot be said that the district (which constitutes one of the most important auriferous regions of the State) has come up to the high expectations then formed of it, still the Murchison does possess what is believed to be the largest solid quartz reef yet mined anywhere—the Great Fingall Reef at Day Dawn—and the phenomenally large and rich iron ore deposits of the Wilgie Mia, in the Weld Range.

The Murchison rose from the position of a pastoral district in the year 1891, when the first gold find of any real importance took place at Nannine. Gold was, however, discovered in 1888, a few miles to the north of what is now the mining centre of Cuddingwarra, but the find attracted but little attention. Since the first discoveries of gold, operations, despite many causes which stood in the way of mining development, have been carried out in the Murchison district, which, including Yalgoo, has been responsible for 1,122,625·97 ounces of the State's total output of gold at the close of the year 1903. There is every reason to believe that this portion of Western Australia will continue to be a prominent gold producer, and that the output will materially increase.

The geological structure of the portion of the Murchison District embraced by Mr. Gibson's work is remarkable for its uniformity. The district may be described as a series of persistent zones of schists and allied metamorphic rocks, which everywhere constitute what may be called the Auriferous Series. These zones of schists are surrounded by granite, which the evidence accumulated during the progress of the field work would seem to indicate belong to two distinct periods, viz.: an older, which has been subject to the shearing, etc., which affected the schists; and a newer, which penetrates the older granite as well as the Auriferous Series.

The greenstone schists are remarkable for their persistent strike and horizontal extent, one belt alone having been proved to extend for at least sixty miles. So far as observations have at present been carried, the schists appear to be merely sheared and foliated igneous rocks. By far the larger portion of Mr. Gibson's duties, however, were of necessity devoted rather to economic than to stratigraphical geology, hence it has not been found possible to devote very much time to the solution of the exact relation of the different greenstones to one another, and such other cognate points. It is quite conceivable that much more detailed research than has hitherto been found possible would result in the recognition of highly metamorphosed sedimentary beds among the foliated greenstones of the Murchison.

Two distinct types of auriferous deposits have been shown to occur in the North Murchison, viz.: the laminated quartzites (which often contain hæmatite to such an extent as to warrant their being classed as iron ones) and the pure quartz reefs.

The quartz reefs occur in the granite, in addition to the greenstones and allied rocks, but it is only those in the latter that have proved to be auriferous to any extent; those occurring in the granite have invariably proved to be of too low a grade to be successfully worked under present conditions.

The quartz reefs occurring at or near the junction of the greenstones and the granite appear to be unusually large and well defined, and outcrop for considerable horizontal distances, whilst the gold contents appear to be more uniformly distributed throughout the body of the reefs than in those associated with the quartzites.

The quartzites form one of the most characteristic features in the district; they are everywhere confined to the greenstones, and extend as roughly parallel bands, many miles in length, and outcrop in the form of rough serrated ridges. The beds vary from almost pure quartz, through varieties of banded jaspers, often of great beauty, to practically pure banded hæmatites, some of which (notably those in the Weld Ranges) might be turned to profitable account as sources of iron ore, under more suitable conditions. The quartzites are not, as their name (under the present somewhat unsatisfactory system of nomenclature) implies, of sedimentary origin, but are merely quartz reefs of a peculiar type. The quartzites themselves are not, as a rule, highly auriferous, except in those places where they are traversed by ordinary quartz reefs; in which latter case, rich but narrow chutes of gold occur.

So far as observations have at present been carried out, within the area examined by Mr. Gibson in the North Murchison, very few workings extend below a vertical depth of 300 feet from the surface.

The following table shows the total gold returns from the mining centres examined, up to the end of 1903:—

	Ore treated. tons.	Gold therefrom. ozs.	Average Grade per ton. ozs.
Lake Austin	34,483·40	71,328·62	2·07
Tuckanarra	11,689·75	15,273·50	1·30
Munarra Gully	13,115·50	8,059·27	·61
Quinns	959·00	1,135·67	1·18
Gabanintha	35,716·75	34,600·15	·96
Nannine	61,955·13	59,002·56	·95
Meekatharra	13,906·33	13,783·09	·99
Abbotts	29,402·00	35,039·01	1·18
District generally	...	*3,087·70	...
Total	203,227·86	†238,221·87	1·17

* Alluvial. † Does not include the alluvial gold.

Considering the number of reefs already proved to exist and those which have been worked with (as shown by the official returns) an average grade of over an ounce to the ton, there are good grounds for judiciously carrying out a more vigorous prospecting policy than has been the case in the past, for the reefs give every promise of being, as a whole, as persistent in depth as such deposits ever can be.

The report and accompanying maps, on being submitted to the Hon. the Minister for Mines, were ordered to be printed for public information.

A. GIBB MAITLAND,
Government Geologist.

Geological Survey Office,
Perth, 28th March, 1904.

THE GEOLOGY AND MINERAL RESOURCES

OF A PART OF

THE MURCHISON GOLDFIELD.

Introduction.

Boundaries of the Field.—The Murchison Goldfield, as originally constituted, was first proclaimed on the 24th of September, 1891. Its boundaries were modified on the 15th of February, 1895, so as to embrace an area of about 21,000 square miles. As defined by the authorities, the goldfield at present is—

> Bounded by lines starting from the summit of Mount Murchison, and extending north-eastward to the summit of Mount Hale; thence east-south-eastward to the summit of Mount Russell; thence south-westward to the north-west corner of the Yilgarn Goldfield (North Coolgardie G.F.? ; thence west-north-westward to the summit of Wyemando Hill, and onwards to the trig. station K 6 on Goonamondey Peak; thence north-westward to the summit of Mount Farmer, and onwards to the summit of Mount Luke, and onwards to the summit of Mount Murchison.

Mining Centres examined and mapped.—The centres examined and reported on were Lake Austin (the Island and the Mainland), Tuckanarra, Quinns, Gabanintha, Nannine, Meekatharra, Abbotts, and the Weld Range. Of all these, with the exception of the Weld Range, maps have been prepared on a scale of 20 chains to one inch, showing all geological boundaries, the strike and dip of all reefs and ore bodies, the position of existing leases, and all shafts and surface workings.

Previous Reports on the Murchison Goldfield.—The following extracts have been taken from various official reports which have appeared from time to time on parts of the Murchison Goldfield and on the goldfields of the Colony generally. In the year 1855 Assistant Surveyor Mr. Robert Austin was sen out by the Government to explore a portion of the interior of Western Australia. On his return he published a report [*] entitled "A Report of an expedition to explore the interior of Western Australia," in which he says:—

> . . . . between Mt. Farmer and Mt. Magnet, 150 miles to the eastward of Mr. Gregory's last bivouac on the Murchison, and 300 miles south-east from Shark Bay, I have passed over 70 miles of undulating country presenting chocolate-coloured mica slate hills and felspar and quartz grit cliffs, in association with quartz and hornblende schists, resting on granite breccia and greenstone, surrounded by plains of red loam, covered with quartz stones and rich black iron ore, and shedding to the north-east into the great interior marsh I have discovered flowing to the north-west; that 100 miles east from the bottom of Hamelin Harbour, or the north arm of Shark Bay, at the place we retreated from on the 12th October, there are white cliffs resembling chalk and quartz grit cliffs with egg-shaped quartz pebbles of various sizes embedded in them, resting on dislocated gneiss rocks, intersected by two walls or veins, one of round and the other of angular quartz stones, cemented in a hard greenish white matrix, and surrounded by red loamy plains covered with these angular and rounded stones; that 100 miles south-south-west from this last-named place, and on the left bank of the Murchison, across my track of the 15th and 16th of November, there are similar pebbly cliffs in association or blended with primary schists; that there are pipeclay plains resting on greenstone around the quartz schists ranges in the vicinity of Mt. Kenneth, and similar plains covered with quartz stones at the base of the felspar cliffs, near our bivouac of the 12th of August; and that all the facts I have alluded to under this head show the accuracy of Sir Roderick Murchison's views relative to the formation of the country to the eastward of the Murchison River and at the back of Shark Bay.
>
> I beg to draw your attention to the first and second items as indicative of a fertile country to the eastward; and to the latter as confirmatory evidence in support of an eminent geologist's [†] opinion that we have in this hitherto unexplored and imprudently neglected portion of our territory probably one of the finest goldfields in the world. I have noted many important facts in support of these opinions, which, if you wish me to lay before you, I shall have much pleasure in submitting for your further consideration, as well as a plan for future operations from a central depôt on the great bend of the Murchison. . . . .

In 1863 (?) Mr. E. C. Hargreaves was sent out to examine Western Australia with the view of determining if, as had been loosely asserted, it would prove to be auriferous. After various excursions into the interior he reported in a paper read before the Royal Geographical Society [‡] that, although rich in copper and iron ores, its rocks, so different from those of New South Wales and Victoria, render it essentially a non-auriferous country.

In the discussion which followed the reading of this paper, Mr. Selwyn, the Geological Surveyor of Victoria, is reported to have said that—

> . . . . . Some of the specimens in which Mr. Hargreaves found indications of copper he thought were analogous to rocks of central South Australia, from Mt. Serle to Mt. Remarkable, in which the great copper mines

---

[*] Journal of the Geographical Society, vol. 26, 1856, page 36.

[†] Sir Roderick I. Murchison, Director General of the Geological Survey of the British

n the Non-Auriferous Character of the Rocks of Western Australia," by E. C.
s. Proceedings of the Royal Geographical Society, Vol. VIII., 1864, p. 32.

of South Australia occur. He thought, however, we ought hardly to take an examination of the coast-line as a proof that the whole of Western Australia was non-auriferous, because if we looked at the enormous expanse of Western Australia, it would be seen that Mr. Hargreaves had traversed it to but a very limited extent; and it was not improbable that there might be regions in which the silurian rocks might re-appear.

In 1870, 1871, and 1872, Mr. H. Y. L. Brown was Government Geologist of the State, and during his term of office examined and published reports on a considerable portion of it, including one —accompanied by a geological sketch map—on the country to the north-east of Champion Bay, W.A.* It is apparently from the data contained in these reports that Governor Weld based the following remarks, which appear in a despatch sent to the Earl of Carnarvon in September, 1874:—

> The mineral riches of this colony are very great. I have never doubted but that they would ultimately become a main source of its advancement. All the different kinds of auriferous quartz known in the other colonies are found abundantly in various parts of this; the question of payable gold is, as I have long since reported, simply a question of time.

In 1893, Mr. H. P. Woodward, then Government Geologist, published a report on the Murchison Goldfield.† In this he says:—

> There are four formations on this field, which are—
>
> | | |
> |---|---|
> | Recent ... | Alluvium of the watercourses, flats, and salt marshes travertin, and other surface deposits. |
> | Mesozoic (?)... | Desert sandstone, horizontally bedded sandstones, clays, pipeclays, gypsum, and ferruginous beds. |
> | Metamorphic | Slates, schists, quartzite, sandstones (mostly ferruginous), limestone, or granite. |
> | Plutonic ... | Granite, diorite, and other dykes. |
>
> The recent formations are always of very limited thickness, rarely, as far as tested, exceeding 15 to 20 feet. They have been derived directly for the most part from the denudation of the desert sandstones, but also in some cases from the metamorphic rocks. . . . . . The mesozoic formation, if represented by the remains of the old tableland, can be seen well in many cliff sections, but up to the present no organic remains have been found in them; but, to judge from the associated gypsum and iron beds, it is highly probable that some will yet be met with. It is probably a portion of the great plain of the interior of Australia, the age of which has been determined as mesozoic, but until fossils are found we shall not be able to determine their correct age. . . . . . The metamorphic rocks outcrop, rising as low ridges wherever the overlying desert sandstone has been removed; they are mostly hard, large quartz reefs often forming the main axes of the ridge, but more generally beds of highly-altered ferruginous quartzite, nearly approaching a mineral vein in character, at the intersection of which the quartz reefs are always richest. Along the principal belt of auriferous country the rocks for the most part strike a little to the west of north and underlie to the west, consisting largely of talcose and granitic rocks, although hornblendic and micaceous slates are also met with. . . . . . Dykes are met with in many places; these are generally either granite or diorite, the latter being of great variety, whilst the former generally contain crystals of foliated talc in cavities.

---

* Report on a Geological Exploration to the north-east of Champion Bay, W.A., by H. Y. L. Brown, Government Geologist.* Perth: By Authority, 1871.

† Report on the Murchison G.F., by H. P. Woodward, Government Geologist. Perth: By Authority, 1893.

Mr. S. Göczel, in an official report on the interior gold region of Western Australia, * in speaking of the rocks of the district, says:—

> . . . . . The archæan rocks form the basis of the whole great interior tableland. Rising into elevations within the auriferous region, they are sometimes overlaid by cappings and beds of ferruginous grits, sandstones, and conglomerates, which hardly ever attain any considerable thickness. . . . . The old greenstones (diorite, diabase, gabbro), including the schistose and banded features (felspar-amphibolites, schists, etc.), form hills and ranges along gigantic breaks in the archæan strata; they generally also indicate those stretches of country in which gold deposits occur.

In speaking of the rocks of the Nannine district, in the same report, he says:—

> We here again find a break in the archæan earth crust; the subsidence of the portions to the West of that break; the formation of reefs, dykes, fissures, and faults, and also the usual alteration of the country rock along their course. . . . . The country formation is dioritic schist, which near the surface and along the lode is altered into talcose and chloritic schists. Banks of ferruginous jasper or schistose siliceous ironstone are running transverse to the reef, and on the lines of intersection rich chutes of gold ore have been found to occur. . . . .

Mr. Frank Reed, in a report on the "Geological Features and State of Development of some of the Mines in the Nannine District," † refers to the country rock of this district as consisting of—

> . . . . . dioritic schist, which occupies a break in the archæan gneissic granite which occurs in this locality. These dioritic schists . . . are undoubtedly of volcanic origin; but whether occurring as a sedimentary rock redeposited in beds, or in its primary state, it is difficult to determine, as it is quite possible that the schistose form may be the result of tangential pressure on the diorite rocks during an age of extreme volcanic activity and disturbance. In the upper strata the felspar in these schists is frequently altered to chloritic or talcose schist, thereby becoming a metamorphic rock by kaolinisation of the felspar. These dioritic schists are traversed by quartz reefs, having generally a north and south course. . . . .

Mr. Reed has also issued a report on the "Auriferous Veins of the Central Goldfields," which appeared in the Annual Report of the Department of Mines ‡ for the year 1896.

Other official reports referring in part to the geology of the Murchison Goldfield are:—

(I.) The Country between Northampton and Peak Hill, by A. Gibb Maitland, Government Geologist. §

(II.) The Country at the Heads of the Sandford and Murchison Rivers, by T. Blatchford, Assistant Geologist. ||

(III.) Lennonville, Mount Magnet, and Boogardie, Murchison Goldfield, by Chas. G. Gibson, Assistant Geologist. ¶

(IV.) The Auriferous Reefs of Cue and Day Dawn, by W. D. Campbell, Assistant Geologist. ††

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* The Interior Gold Region of Western Australia, by S. Göczel. Annual Report of the Department of Mines for year 1894.

† Report on the Geological Features and State of Development of some Mines in the Nannine District, Murchison G.F., by Frank Reed. Annual Report of the Department of Mines for the year 1895, p. 44. Perth: By Authority.

‡ Report on the Auriferous Veins of the Central Goldfields, by Frank Reed. Annual Report of the Department of Mines for the year 1896, p. 29. Perth: By Authority.

§ Annual Report of the Geological Survey for the year 1897, p. 14. Perth: By Authority.

|| Annual Report of the Geological Survey for the year 1898, p. 36. Perth: By Authority.

eological Survey, Bulletin 8. Perth: By Authority, 1903.

logical Survey, Bulletin No. 7. Perth: By Authority, 1903.

Early History of the Murchison Goldfield.*—The first authenticated discovery of gold within the limits of what is now the Yalgoo and Murchison Goldfields was made in the vicinity of Yuin, near the head waters of the Greenough River. The gold was found in a reef occurring as a blow at a spot about five miles east of Yuin.

The first find of any real importance took place at Nannine in the year 1891, and for this the sums of £500 and £100 were respectively advanced to Messrs. Connelly and Douglas, the discoverers. Before many months there were between 300 and 400 men on the field.

A few years before, viz., in 1888, gold was said to have been discovered a few miles to the north of what is now the town of Cuddingwarra, but it appears to have attracted but little attention.

General Geological Features.

THE GREENSTONES.

The auriferous series of the North Murchison Goldfield consists of massive and foliated greenstones, which are found in belts of varying extent associated with the granites, and comprise pyroxenites, diorites, amphibolites, and altered and schistose forms of these. Some of the belts are of considerable extent; for example, that embracing the mining centres of Mount Magnet, Lake Austin, Day Dawn, and Cuddingwarra, which has been proved to be continuous for at least 60 miles in length, and to have an average width of from 10 to 15 miles; others, again, are of comparatively small area.

The true relation of these greenstones to the main body of the granite is not at present quite clear; it would appear, however, that there have been at least two intrusions of granite, one of which is undoubtedly newer than the greenstones, but whether these latter have been intruded into the main body of the older granite, or the older granite into them, is a question which will necessitate more detailed field work before it can be definitely answered, and will always be rendered difficult owing to the presence of the extensive beds of recent superficial deposits which cover such a large area of the country, and hide all natural sections.

It is within these greenstone belts that, generally speaking, the gold-bearing reefs are always found, payable reefs only having been found in one or two cases on this field in the granite country, viz., at Quinns and Nannine, at both of which places, however, they are of low grade. It is within the greenstones, too, that the belts of hæmatite-bearing quartzites † which form such a characteristic feature of this district occur. In no single instance have these been found in the granite country, a fact which helps to the theory that they are nothing more or less than highly altered bands of greenstone schists.

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* For a somewhat fuller account of the early history of the Murchison Goldfield, see Bulletin 8 of the Geological Survey, page 8.

† The name "quartzite" which has been applied to this type of rock is here not used in its strict geological sense, but has been loosely given to them for want of a more suitable term. (C.G.G.)

THE GRANITES.

The granite occurring throughout the district varies considerably both in macroscopic and microscopic properties; that occurring in the southern portion of the field and in the neighbourhood of Mt. Magnet is a biotite granite, while that at Cue, Nannine, Gabanintha, and other more northern centres is a hornblendic variety closely resembling syenite in composition in certain localities (*e.g.*, Cue), and appears to be of later origin than the former variety, and is certainly later than the greenstones, into which it is frequently found intruding.

The following is an analysis of a sample [**3796**] of this type of rock from the 160ft. level, Agamemnon G.M., Cue:—

Silica, (SiO_2)	63·62	per cent.
Carbonic anhydride, CO_2	*Nil*	
Titanic oxide, TiO_2	·72	„
Ferrous oxide, FeO	3·47	„
Ferric oxide, Fe_2O_3	3·29	„
Alumina, Al_2O_3	14·38	„
Manganous oxide, MnO	·28	„
Magnesia, MgO	3·13	„
Lime, CaO	5·43	„
Ferrous sulphide, FeS_2	*Nil*	
Soda, Na_2O	4·40	„
Potash, K_2O	1·20	„
Hygroscopic water, H_2O	·22	„
Combined water, H_2O	·06	„
	100·20	„

Specific Gravity ... ... 2·76

Analyst ... ... E. S. Simpson.

This rock is a grano-diorite, intermediate between a true hornblende granite and a quartz diorite, the silica percentage being too low for the former and too high for the latter. A section (258) of it under the microscope shows it to consist of—

(*a.*) Felspar, mostly plagioclase (oligoclase) with a little orthoclase; the plagioclases are in large tabular crystals and the orthoclase in clear grains and lumps; the former are, in one or two cases, considerably clouded from the presence of alteration products, principally saussurite. The felspar forms by far the greater portion of the section.

(*b.*) Quartz, fairly plentiful in small irregular grains and lumps.

(*c.*) Biotite, abundant in large flakes and plates.

(*d.*) Hornblende, fairly plentiful, in good sized flakes and irregular lumps; a good deal of it is in parallel intergrowth with the biotite; it is a dark green variety and shows frequent twinning.

(*e.*) Augite: a few small crystals of pale-coloured augite occur associated with the hornblende.

The rock is very similar to that found occurring near Meekatharra.*

The following are four analyses of rocks obtained from Cue during an examination of that district. These analyses were originally intended for use in connection with Bulletin VII.—Notes on the Auriferous Reefs of Cue and Day Dawn, by Mr. W. D. Campbell—but not being available at the time the work went to press had to be omitted, and are now included, as many of the rocks of the district under review bear a remarkable resemblance to those of Cue:—

Geological Museum Number ...	[3832]	[3976]	[3823]	[3847]
Silica SiO_2	50·12	68·46	48·10	48·09
Carbonic anhydride CO_2 ...	·03	2·00	·12	·12
Titanic oxide TiO_2	·26	·61	·41	·12
Water (combined) H_2O ...	·03	·83	·33	2·05
Soda Na_2O	1·95	4·01	2·11	2·17
Potash K_2O	·08	2·05	·14	·07
Magnesia MgO	10·00	2·08	6·38	7·56
Lime CaO	13·04	2·63	12·73	11·30
Manganous oxide MnO ...	·29	Trace	·05	·29
Ferrous oxide FeO	7·01	3·20	4·33	6·99
Ferric oxide Fe_2O_3	1·66	2·27	10·32	1·43
Alumina Al_2O_3	14·90	12·25	15·41	19·77
Ferrous sulphide FeS_2 ...	·13	·15	·25	·11
Water (hygroscopic) H_2O ...	·13	·05	·04	·17
	99·63	100·59	100·92	100·24
Specific Gravity ...	3·02	...	8·11	2·98

[3832] is a hypersthene rock (norite) from a spot on the north side of hill between Lady Forrest and Polar Star G.Ms. Analyst, E. S. Simpson.

[3976] is a felspar porphyry from a depth of 2,030 feet D.D. bore on G.M.L. 226, Day Dawn. Analyst, C. C. Williams.

[3823] is a fine-grained greenstone (amphibolite) similar to that found all over the Murchison Goldfield and is from a spot 9 chains south of Princess Extended G.M.L. 1232, Cue. Analyst, C. C. Williams.

[3847] is a coarse-grained amphibolite from the well on Water Reserve 7745, Cue.

THE HÆMATITE-BEARING QUARTZITES.†

A characteristic feature of the whole Murchison Goldfield is the frequent occurrence of belts of hæmatite-bearing quartzites. These, as has been before stated, only occur in the greenstones, and extend as roughly parallel bands often for many miles, being generally found occurring in the form of low rough ridges and ranges, for, being harder than the surrounding rocks, they have withstood longer the gradual action of weathering; the quartzites are generally auriferous, but are, as a rule, too low grade to be of any commercial importance under present conditions; however, they usually have a very beneficial effect on the quartz reefs in their immediate vicinity, rich chutes of gold being almost invariably found wherever the quartz reefs come in actual contact with or cross them. Frequently these quartzites are crossed by transverse lines of fault, and along these rich pockets of stone are often found.*

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* Page 61. † *See* footnote, Page 13.

The chemical composition of these quartzites varies from almost pure banded blue and white quartz to a practically pure banded hæmatite. They will be found more fully described, with results of analyses attached, under the particular localities in which they occur.

THE SUPERFICIAL DEPOSITS.

Overlying the greater part of the country are beds of recent deposits, which cover the country to depths varying from a few inches to many feet; these result from the gradual weathering of the older rocks, and when derived from and overlying the greenstones are of a fine red clayey nature, but when overlying granite they are lighter in colour and much more sandy.

The ironstone gravel deposits—which are so common throughout the Eastern fields—are not met with to any great extent in this district, and where found are only in very small areas, as the cappings of greenstone hills and ridges.

THE REEFS.

With regard to the reefs of the district, those which occur in connection with the quartzites, though frequently of considerable size, are almost invariably very irregular, and their gold contents are very patchy, small rich chutes, as a rule, being obtained at their point of contact or intersection with the quartzites, while the bulk of the stone is blank or at best of very low grade; the reefs of this class, therefore, are of not much use to a large company, owing to the gold returns being too uncertain, but are frequently very good things for the prospectors, as thousands of ounces are often taken out of one small pocket, and this most frequently very close to the surface. The reefs, which occur wholly in the greenstones and at some distance from the quartzites, are as a rule much more regular, both in size and in their gold contents, and although this is very often found to occur in them in chutes, these are usually of considerable extent. These reefs, generally speaking, give every promise of living to a depth, and if a good many of them that are now abandoned were sunk on and systematically worked to a reasonable depth they would probably give very satisfactory returns. At present practically no work has been done in the North Murchison district below a vertical depth of about 300 feet.

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* *Vide* Report on Boogardie and Mount Magnet, by C. G. Gibson, Assistant Geologist; lletin 8, page 16. Perth: By Authority.

Water.

The field, as a whole, is well watered, and, generally speaking, fresh water can be obtained anywhere by sinking to a comparatively shallow depth, the only exception to this rule being in the immediate vicinity of the salt lakes, where the water is invariably salt; however, by sinking a mile or so away from these, fresh water is usually obtained.

Timber.

Timber is rapidly becoming a serious item on this field, mulga being the only kind available, both for mining purposes and for fuel, and is rapidly becoming exhausted, and in the more populous parts has to be brought in from considerable distances.

Description of the Individual Mining Centres.

The following is a description of the salient features in the different mining centres of Lake Austin, Tuckanarra, Quinns, Gabanintha, and Star of the East, Nannine, Meekatharra, Abbotts, and the Wilgie Mia, Weld Range. The descriptions are, for convenience, arranged in geographical order, beginning with Lake Austin on the south and taking each centre northwards. In order to facilitate the correct understanding of the various descriptive portions of the report a geological map of each centre has been prepared and attached to this report. These maps are on a scale of 20 chains to an inch, and show as much detail as this scale will permit. They should prove of some general value.

The Island and Mainland, Lake Austin.

The Island.

General Topography.

The Island consists of a series of low greenstone and quartzite ridges, rising abruptly to a height of about 100 feet from the salt flat known as Lake Austin. It is about three miles in length, and nearly a mile across at its widest point; its general trend is a little east of north and west of south. It is traversed by a series of parallel quartzite bars, the main lines of which run almost absolutely straight from end to end of it. These usually rise up above the greenstones as low, rough hills and ridges, and are from a few feet to as much as two chains in width, and dip at a steep angle to the westward. They run very true, and are very little faulted, differing in this respect from the otherwise similar quartzites of Boogardie.[*]

To the eastward of the Island the salt lake stretches unbroken for several miles, while on the west is a mixture of salt lake and low sand dunes extending for many miles, the sand dunes rising to a height of 10 to 20 feet, with narrow arms of salt lake running between them in all directions; a stretch of lake some half-a-mile in width separates the Island from the mainland at either end. The boundary of the lake, except along the eastern shore of the Island and the southern shore of the Mainland, is, on the whole, very indefinite, and it is generally surrounded by low sand dunes, among which narrow arms of the lake run in all directions.

THE GREENSTONES.

These consist principally of a coarse-grained typical diorite, as well as a slightly foliated rock, which is probably only an altered form of the above; this latter occurs only over one or two small areas, the prevailing type of rock being massive and very coarse-grained. Sections of several samples of these rocks show them to consist essentially of pale green hornblende and felspar in about equal proportions, the hornblende being in both large and small crystals and plates, while the felspar (plagioclase) for the most part is in small crystals and irregular grains; it is somewhat decomposed; a little secondary quartz is also present. The greenstones are for the most part very decomposed and weathered down to a depth of from 120 to 150 feet.

THE HÆMATITE-BEARING QUARTZITES.

These are the main feature of the district, and occur as bands from a few feet up to two chains in width, running parallel to each other on a general north-north-east and south-south-west bearing, with a steep dip to the westward. They consist of banded quartz and hæmatite with magnetite, and are exactly similar to those occurring in the Boogardie District, and in all cases are found to be highly magnetic; they appear to be merely highly altered bands of foliated greenstone, and in some places can be seen to tail out imperceptibly into the latter. They are older than the quartz veins of the district, as the latter are often found cutting through them, and invariably carry a slight trace of gold, but not sufficient to make them payable, and at a depth generally carry a considerable quantity of pyrites. Their appearance at a depth is exactly similar to that at the surface, except in one case where, in a small bar at the 250 feet level in the Island Eureka G.M., a considerable amount of the hæmatite of the bar appears to be dying out and its place taken by blue quartz; this, however, is only on the hanging wall edge of the bar, and if it was cut through it would probably be found to still maintain its surface characteristics.

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[*] Geological Survey, Bulletin 8, page 16. Perth: By Authority, 1903.

The following are two partial analyses made in the Departmental laboratory of samples of these quartzites taken from the north end of the Island:—

Geological Museum Number.	[5110]	[5109]
Iron, Fe	39·65 per cent.	42·11 per cent.
Silica, SiO_2	38·42 ,,	36·38 ,,
Phosphorus P	·068 ,,	·106 ,,
Sulphur S	·042 ,,	·054 ,,
Water (hygroscopic) H_2O ...	·12 ,,	·14 ,,
Water (combined) H_2O ...	4·03 ,,	2·49 ,,

The numbers [5110], [5109] refer to the numbers in the Museum Register.

THE REEFS.

These almost invariably run parallel to and close alongside the quartzite bars, dipping in the same direction as the latter, which is nearly always towards the west, and generally consist of white quartz, being very irregular both in size and in their gold contents; they are always very broken and unsettled in the upper workings, but become more defined and regular in the harder country at the deeper levels. The quartz reefs appear to be of later origin than the quartzites, as in several cases they are found cutting through the latter; in such cases they are usually much richer at the point of intersection. The reefs which run alongside the quartzite bars are invariably found to carry the best gold when they are in actual contact with the bar; as soon as they are separated from it by even a few inches of country rock the stone begins to get appreciably poorer. Many of the quartz reefs in this district were phenomenally rich near the surface; the chutes, however, were small and extended for no distance, either longitudinally or vertically; at a depth a little below water level they always contain considerable amounts of pyrites.

A fair amount of alluvial gold was obtained here in the early days, but appears to be all worked out now, as nothing is being done in that line; the areas worked were small. Speaking of the alluvial workings, Mr. H. P. Woodward, late Government Geologist, says:—*

> The diggings on the Island were some of the richest and most concentrated on the field, and it is the only place where anything like deep ground was met with, a defined gutter being found on the bed rock at 15ft. from the surface. The alluvial ground ran down from a saddle near the centre of the Island in an easterly and westerly direction towards the lake, but no auriferous reefs have yet been found immediately on its course. The sinking was pretty tough in places, as the alluvium was cemented together by gypsum.

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* Report on the Murchison G.F. By H. P. Woodward, Government Geologist, p
Perth: By Authority, 1893.

WATER.

Water was met with in all the mines here at depths varying from 60 to 90 feet, its level being about twelve feet below the surface of the lake; it is present in very large amount, but is exceedingly salt, this being almost the only centre on the Murchison Goldfield where such is the case, and water for domestic purposes, as well as for cyaniding, has to be carted or pumped from wells several miles distant. The water from the mines is, however, being used for battery purposes, with very satisfactory results. Most of the water used on the Island for domestic purposes is brought by train from Cue; the principal mines, however, have wells situated some three miles to the south and a couple of miles inland from the edge of the lake. A good supply of fair water is obtained from these. At the Mainland salt water is also met with in a large quantity a few feet below the level of the lake bed; water for domestic purposes and for cyaniding is here being pumped from a well near Day Dawn; fair water has also been struck at a shallow depth in a well about a mile and a-half inland from the shore of the lake.

TIMBER.

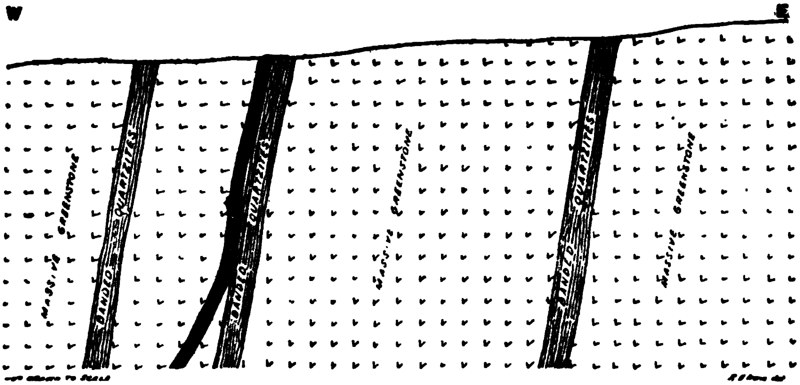
There is practically no timber in the neighbourhood, even of sufficient size for fuel, and both for this and for mining purposes it has to be brought in considerable distances either by train or wagons.

The Mines.

The following is a brief description of the principal mines in existence at the Island at the time of my visit:—

ISLAND EUREKA G.M. CO., LTD., 5D, 9D, 142D.—This Company is working a fair-sized quartz reef, which runs slightly east of north alongside a quartzite bar and dips with it at a fairly steep angle to the westward. In the upper levels the reef is right alongside the quartzite bar, but in the lower levels it gets off it and dips at a somewhat flatter angle. The reef is from four to seven feet in width, and consists of white quartz, with from six to 18 inches of schistose formation on the hanging wall, and has clean, well-defined walls. The richest stone is invariably found where the reef comes in actual contact with the quartzite bar, along the hanging wall of which it runs. A second large quartzite bar runs parallel to the reef, some 20 to 30 feet to the west of it; this bar is almost vertical, while the reef is dipping towards the west: assuming the reef to keep on its present course, a further supply of rich stone should be met with where they come in contact. (Fig. 1.) The quartzite bars, as far as tested on this property, have been found to carry a little gold, but not sufficient to pay working expenses. Both these and the quartz reefs are heavily mineralised about 150 feet or 60 feet below water level. Some very rich pockets of stone have been taken out of the reef, especially from near the surface; a considerable amount of work has been done on it, the main shaft has been sunk to a vertical depth of 315 feet, and levels put in at 250 feet for about 420 feet north, at 175 feet for about the same distance north and 150 feet south, and at 125 feet for about 350 feet north and 200 feet south, and a considerable amount of stoping has been done from each level. Water was met with at about 90 feet, and is now being pumped from about 260 feet at the rate of some 1,500 gallons per hour; it is exceedingly salt, and unfit for use either in the boilers or for cyanide purposes; it is, however, being used with satisfactory results in the battery. The country consists of a somewhat foliated greenstone, soft and decomposed to about 150 feet, but very hard and settled below this level.

Fig. 1.



CROSS SECTION NEAR MAIN SHAFT SHEWING THE MODE OF OCCURRENCE OF THE ISLAND EUREKA REEF. MURCHISON G.F.

Up to the end of 1903 this mine, as shown by the following table, has crushed 13,238·40 tons of stone for a yield of 19,194·39ozs. of gold, being at the rate of 1·45oz. per ton, and worth £3 17s. 10½d. per oz.

Island Eureka G.M. Co., Ltd., G.M.Ls. 5d, 9d, 142d.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Previous to 1897 ...	17·00	1,047·00	61·59
1897	406·40	1,367·25	3·36
1898	549·00	894·50	1·63
1899	30·50	429·18	14·07
1900	810·50	1,630·41	2·01
1901	2,405·00	3,426·30	1·42
1902	4,700·00	6,154·57	1·31
1903	4,320·00	4,245·18	·98
Total ...	**13,238·40**	**19,194·39**	**1·45**

Island Eureka South G.M.L. 281d, etc. (late Chicago Shamrock).—The workings on this property are situated on a quartz reef which runs along the western side of a large quartzite bar, and dips with it at a flat angle to the westward. The reef is from two to three feet in width, and is rather irregular; the quartzite bar forms the footwall of the reef, and it is along this bar that the best stone is got.

The present main shaft is down about 150 feet, and a small amount of driving and stoping has been done at this level; salt water was struck at about 60 feet and is very abundant; it is now being pumped from the lower levels at the rate of about 2,000 gallons per hour. A lot of work has been done on the reef down to water level by the original prospectors, and some phenomenally rich patches of stone were taken out. A second parallel reef runs through the property a few chains further west along the eastern side of a large parallel quartzite bar; so far, practically no work has been done upon it.

The following table shows that up to the end of 1903 the crushings from these leases (Chicago Shamrock), were 164·10 tons for 888·93oz., including 63·68oz. specimens, being at the rate of 5·42oz. per ton, and worth £3 18s. 10½d. per oz.

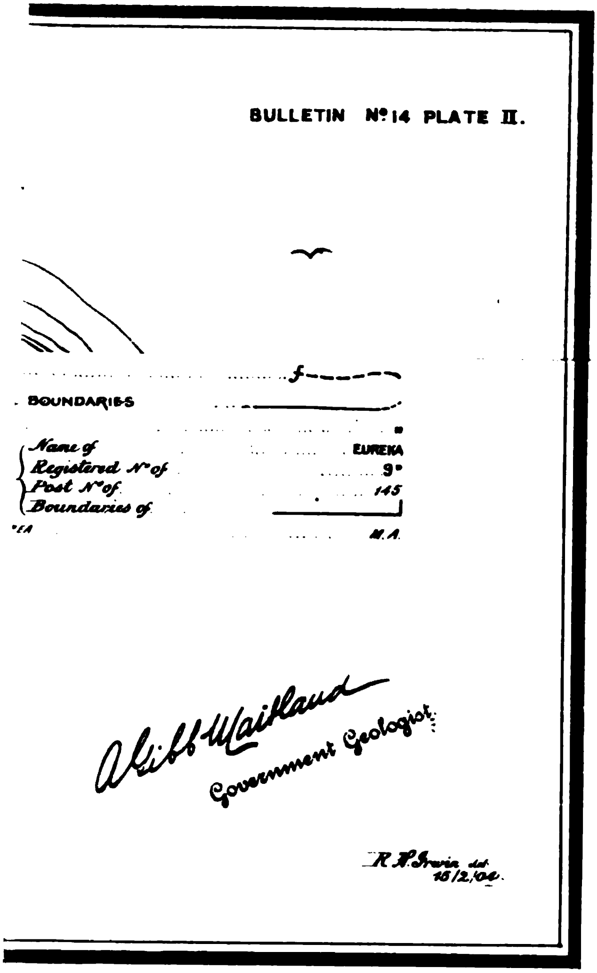
ISLAND EUREKA SOUTH G.M.Ls. 281D, ETC.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	5·10	343·15	67·28
1898	70·00	86·95	1·24
1900	58·00	†427·83	7·38
1903	31·00	31·00	1·00
Total ...	**164·10**	**888·93**	**5·42**

† Includes 63·68oz. dollied and specimens.

Golconda Mines, Ltd., G.M.Ls. 35d, 42d, 68d, 69d, 70d, 74d, 79d, 143d.—Several lines of reef run through this property on a general bearing slightly east of north, and a large amount of work has been done upon them. At the time of my visit the mine was almost abandoned, and only a little work was being done in the upper levels; I was unable to examine the lower workings, owing to their being flooded. The main, or Golconda, reef is a large white quartz reef, running along the western side of a large quartzite bar, and dipping with it at a fairly steep angle to the west. This reef is in places as much as eight feet in width, but in the upper levels is very irregular. The best stone was obtained on the footwall, especially where the reef came in actual contact with the quartzite bar. As in most of the other mines in this district, some very rich ockets were found in the upper workings; these, however, were of

BULLETIN No 14 PLATE II.



A Gibb Maitland
Government Geologist.

R. F. Irwin del.
16/2/04.

H. J. Pether, Government Photolithographer, Perth, W. A.

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The present main shaft is down about 150 feet, and a small amount of driving and stoping has been done at this level; salt water was struck at about 60 feet and is very abundant; it is now being pumped from the lower levels at the rate of about 2,000 gallons per hour. A lot of work has been done on the reef down to water level by the original prospectors, and some phenomenally rich patches of stone were taken out. A second parallel reef runs through the property a few chains further west along the eastern side of a large parallel quartzite bar; so far, practically no work has been done upon it.

The following table shows that up to the end of 1903 the crushings from these leases (Chicago Shamrock), were 164·10 tons for 888·93oz., including 63·68oz. specimens, being at the rate of 5·42oz. per ton, and worth £3 18s. 10½d. per oz.

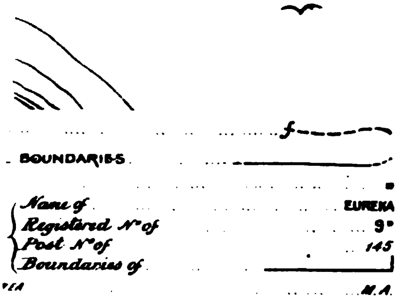
Island Eureka South G.M.Ls. 281d, etc.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
1897	5·10	343·15	67·28
1898	70·00	86·95	1·24
1900	58·00	† 427·83	7·38
1903	31·00	31·00	1·00
Total ...	**164·10**	**888·93**	**5·42**

† Includes 63·63oz. dollied and specimens.

Golconda Mines, Ltd., G.M.Ls. 35d, 42d, 68d, 69d, 70d, 74d, 79d, 143d.—Several lines of reef run through this property on a general bearing slightly east of north, and a large amount of work has been done upon them. At the time of my visit the mine was almost abandoned, and only a little work was being done in the upper levels; I was unable to examine the lower workings, owing to their being flooded. The main, or Golconda, reef is a large white quartz reef, running along the western side of a large quartzite bar, and dipping with it at a fairly steep angle to the west. This reef is in places as much as eight feet in width, but in the upper levels is very irregular. The best stone was obtained on the footwall, especially where the reef came in actual contact with the quartzite bar. As in most of the other mines in this district, some very rich pockets were found in the upper workings; these, however, were of

BULLETIN No. 14 PLATE II.



A. Gibb Maitland
Government Geologist.

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very limited extent. In addition to the above reef, the Eureka lode also runs through the property. A shaft has been sunk to cut this near the Company's southern boundary, and a little work has been done upon it at a depth of about 180 feet.

Salt water was struck at about 90 feet, at which point the country begins to get hard and settled.

This mine, as may be seen by the table, has, up to the end of 1903, crushed 11,342·00 tons for 21,489·15oz., including 110·80oz. dollied and specimens, being at the rate of 1·89oz. per ton, and worth £3 17s. 6d. per oz.

The following tables, compiled from the latest official statistics, show the gold returns from the various other mines in the district up to the end of 1903:—

GOLCONDA MINES, LTD., G.M.Ls. 35D, 42D, 68D, 69D, 70D, 74D, 79D. 143D.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Previous to 1897 ...	4,700·00	7,537·00	1·60
1897	1,335·00	3,244·25	2·43
1898	1,783·00	3,990·83	2·23
1899	2,787·00	4,961·16	1·78
1900	170·00	57·05	·33
1902	330·00	311·75	·94
1903	237·00	*1,387·11	5·85
Total ...	11,342·00	21,489·15	1·89

* Includes 110·80oz. dollied and specimens, and 7·00oz. alluvial.

The Mainland.

The Mainland exactly resembles the Island in its general configuration, rising on the south abruptly out of the salt lake and on the north and north-west from the alluvial flats which cover the greater part of the country between Lake Austin and Cue. It consists of a series of low, rough greenstone and quartzite ridges, whose general trend is about east-north-east and west-south-west, narrowed to a point at a spot about a mile and a-half north-east of the most northern extremity of the Island and then widening out gradually as it proceeds easterly, the edge of the lake maintaining a general easterly direction. The country rock is exactly the same as at the Island, consisting of a coarse-grained typical diorite very decomposed and broken down to a depth of about 100 feet. The only difference between the two places is that the quartzites at the Mainland have a more easterly and westerly strike, and are more faulted than those of the Island. In one or two places these lines of faults have been worked apparently in the hope of finding rich chutes such as are found under similar conditions at Boogardie.* The quartz reefs here, for the most part, run alongside the quartzite bars, and, as at the Island, are richest where in actual contact with them.

At the time of my visit very little work was being done at either the Island or the Mainland; in fact, at the latter place absolutely no work at all was going on, the only mine in existence —the Mainland Consols—being then under extended exemption. At the Island work was being carried on at the Island Eureka, Island Eureka South, and to a small extent on the Golconda.

One or two alluvial miners were also at work on the Island, but very little gold is obtained from this source.

The Mines.

The following is a brief description of the principal mines in xistence at the Mainland at the time of my visit.

MAINLAND CONSOLS G.M.Ls., 6D, 60D, 61D.—At the time of my visit this property was under exemption, and I was unable to examine the lower workings owing to their being flooded. A large amount of work of a rather irregular nature appears to have been done, especially in the upper levels. Two lines of reef have been worked; one, the main line, being an approximately north-east and south-west reef running alongside a large quartzite bar and dipping to the north-west; the other, a smaller reef running at right angles to the former and dipping at a flat angle towards the north-east. This reef is from one to three feet wide where seen in the upper levels; the chute of gold was only some 50 feet in length and has been completely worked out, some very rich stone having been obtained near the surface in the early days.

The main reef is very irregular, both in size and in its gold contents, varying from one to eight feet in width. It runs alongside and to the north-west of a large quartzite bar which runs on a bearing of about 60 deg. and dips steeply to the north-west.

The reef has been followed for a considerable distance into the adjoining leases on the north-east and a large amount of work has been done upon it. The greater part of the stone is of low grade, but very rich pockets occur here and there. These pockets are always small, but are phenomenally rich and are generally found in contact with the main quartzite bar. The quartzite bars themselves, which run roughly parallel to each other, invariably carry a slight trace of gold, but are of too low grade to pay to work; both they and the quartz reefs carry considerable quantities of pyrites below water level. Water was met with at about 60 feet, and is very plentiful and extremely salt. The country rock is a coarse-grained diorite, considerably decomposed to a depth of about 120 feet.

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* Geological Survey, Bulletin 8, p. 16. Perth: By Authority, 1903.

This property, as may be seen by the table, has, up to the end of 1903, crushed 6,589·15 tons for a yield of 21,833·47oz., being at the rate of 3·31oz. per ton.

MAINLAND CONSOLS G.M.Ls., 6D, 60D, 61D.

Year.	Ore crushed.	Gold therefrom.	Rate per ton.
	tons.	ozs.	ozs.
Previous to 1897 ...	1,373·00	14,612·00	10·64
1897	1,726·15	3,124·62	1·81
1898	70·00	304·00	4·34
1899	700·00	311·00	·44
1900	1,607·00	2,024·55	1·26
1901	372·00	405·50	1·09
1903	741·00	1,051·80	1·42
Total ...	6,589·15	21,833·47	3·31

Minor Gold Returns from the Island and the Mainland to end of 1903.

THE ISLAND.

NAME OF LEASE.	No. of Lease.	Ore milled. tons.	Gold yield. ozs.	Average oz. per ton.
Island Lake Austin G.M. Co. ...	8D, 40D	1,807·00	633·41	·35
Island Lake Austin South G.M. Co.	106D	20·00	2·00	·10
New Orient	155D	763·50	3,441·83	4·50
Von Moltke	11D	...	* 33·00 † 61·91	... ...
Sundry claims	...	...	* 9·00	...
Sundry parcels treated at Island Lake Austin battery	...	119·00	53·00	·44
Totals	...	3,709·50	4,234·15	1·56

* Alluvial. † Dollied and specimens.

The Mainland.

Name of Lease.	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
Comet	313D	22·00	* 310·00	14·09
Ingot	204D	30·00	† 101·65	3·38
Mainland East	97D	20·00	69·78	3·48
Mainland Eureka (late Mainland Consols Extended North, 147D)	161D (147D)	85·00	‡ 1,115·44	13·18
Perseverance	171D (85D)	119·70	§ 737·60	6·16
Wild Cat	135D	163·55	‖ 1,124·65	6·87
Total	...	440·25	¶ 3,459·12	7·85

* Includes 238·00ozs. dollied and specimens.
† " 34·50 " "
‡ " 837·19 " "
§ " 405·55 " "
‖ " 274·65 " "
¶ " 1,789·89 " "

Total Yield from District.

	No. of Lease.	Ore Milled. tons.	Gold Yield. ozs.	Average ozs. per ton.
The Island...	...	27,454·00	*45,806·62	1·67
The Mainland	...	7,029·40	†25,292·59	3·59
Total	...	34,483·40	71,099·21	2·06

* Includes 49·00ozs. alluvial, and 236·39ozs. dollied and specimens.
† " 1,789·89ozs. dollied and specimens.

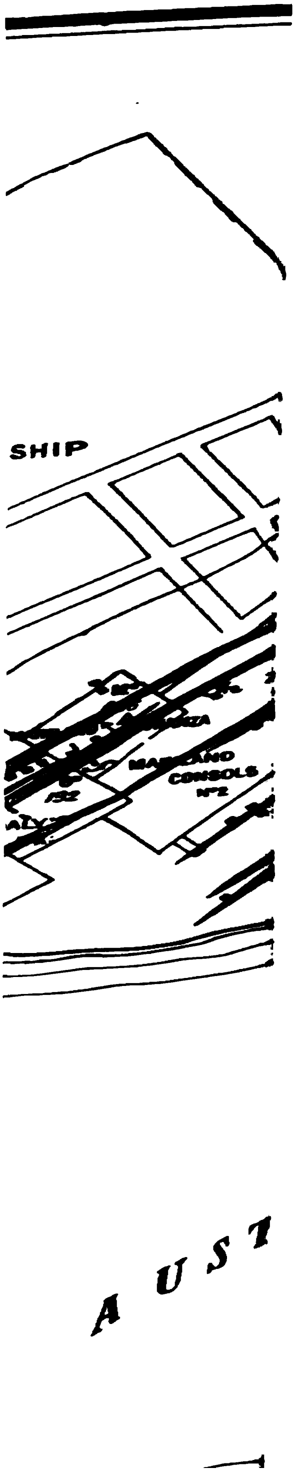
Tuckanarra.

This centre is situated about 26 miles slightly east of north of Cue townsite, and just outside the southern boundary of the Nannine District.

General Topography.

The greater part of the country in the neighbourhood of Tuckanarra consists of level plains covered with recent deposits, through which rise occasional low ridges of greenstone traversed by, and owing their origin to, numerous parallel bands of hæmatite-bearing quartzites. These ridges seldom rise more than 60 or 70 feet above the surrounding plain.

Three or four miles to the east of the townsite the ridges become higher and more numerous, and continue thus for about four miles, when their place is taken by an undulating belt of granite


SHIP
CONSOLS
Nº2
AUST

country running about north and south. About two miles to the north-east of the townsite are a few small outcrops of granite, evidently part of a large body extending northward from this point and hidden by the superficial deposits which cover this part of the country to a considerable depth.

THE GREENSTONES.

The greenstones, within which the quartz reefs and the hæmatite-bearing quartzites occur, are the staple formation of the district; the main mass of granite to the north-east has evidently been intruded into them, and they are also intersected by several north and south granitic dykes which are apparently offshoots from the main body. They are for the most part massive, but are very much weathered and decomposed near the surface, and comprise diorites, quartz-diorites, and amphibolites. Of two specimens microscopically examined, the first [5316], taken from a spot 30 chains west of Boyd's Reward G.M.L., is a fine-grained, greenish rock, showing slight signs of foliation; a section (460) of it, seen under the microscope, shows it to consist of—

(*a*.) Hornblende, forming almost the entire section and being in small and irregular crystals and fibrous aggregates; it is a pale green variety showing strong pleochroism.

(*b*.) Felspar, occurring for the most part in small, clear grains, but a few small, lath-shaped crystals also occur throughout the section. A little ilmenite is also present in small scattered grains, and is in part altered into colourless to pale brown leucoxene.

A second specimen [5317], taken from 30 chains south-west of the same lease, is a coarse-grained, dark green, massive rock, with no signs of foliation; a section (461) of this, seen under the microscope, shows it to consist essentially of hornblende and felspar, together with a little quartz and some ilmenite.

The hornblende occurs principally in the form of large plates and irregularly formed crystals, and is considerably chloritised in parts.

Felspar is fairly abundant, and is probably principally oligoclase; it is considerably clouded from the presence of alteration products. Ilmenite is plentiful, both as grains and partially formed crystals; in a few cases it is altered into leucoxene.

Quartz is present, in small quantity, in the form of irregular grains and blebs.

THE QUARTZITES.

Traversing the greenstones are numerous parallel bands of hæmatite-bearing quartzites. North of the railway line these run in a general north-north-easterly direction, but south of it they take a sudden turn to the east, and run on a bearing varying from south-east and north-west to almost due east and west. These quartzites are similar to those occurring at Boogardie, which have already been described in the geological report* on that district as—

> Old fault lines or joints along which the original greenstones have been highly foliated parallel to the line of faulting, and thus formed zones of weakness along which thermal solutions containing iron, silica, etc., have forced their way to the surface, and gradually converted the original foliated greenstones into their present form.

They here run in narrow parallel belts, occasionally passing imperceptibly into foliated greenstone, from two or three feet to as much as a chain or two in width, and from one to five chains apart, and can be followed on the surface for a considerable distance. They are fairly regular in their course, but are crossed by numerous faults which, as a rule, throw them slightly to the west.

These lines of fault if properly prospected would, no doubt, be found to yield rich chutes of stone similar to those found at Boogardie.*

As far as tested, these bars have been found to carry a small amount of gold, but in no case have they proved rich enough to pay for working. They vary considerably in their appearance, in some the hæmatite and quartz being in fairly wide, well-defined bands, while in others the banding is hardly visible in a hand specimen; they also vary greatly in the percentage of iron present in them, though in no case is this exceptionally high.

A partial analysis, made in the Departmental laboratory, of two typical samples, gave results as follows:—

	[5324.]	[5327.]	
Metallic iron ...	40·55	... 38·15	per cent.
Silica	36·64	... 38·54	„
Phosphorus ...	·02	... ·20	„
Sulphur	·02	... ·03	„
Hygroscopic water	·07	... ·17	„
Combined water ...	4·13	... 3·75	„

[5327] is from a spot on the telegraph line 8¼ miles north-east from Tuckanarra.

[5324] is from about two chains north of locality of [5327].

The Granites.

Intersecting the greenstones in the northern portion of the field are several large granitic dykes. These run in a general north and south direction, and are apparently offshoots from the main body farther north, and vary in appearance from a fine-grained felsite to a coarse granite; a section (462) of a specimen [5318] of this latter type, taken from a large dyke about five chains east of G.M.L. 146, seen under the microscope shows it to be a holocrystalline rock consisting of—

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* Geological Survey, Bulletin 8, page 16. Perth: By Authority, 1903.

(*a.*) Quartz: very abundant, in large irregular lumps and grains almost entirely devoid of crystalline boundaries.

(*b.*) Felspar: also very abundant, and consisting principally of orthoclase and oligoclase; it occurs for the most part in irregular lumps with few signs of crystalline boundaries; a little of it is micrographically intergrown with the quartz.

(*c.*) Muscovite: fairly plentiful throughout the section in the form of colourless ragged flakes.

(*d.*) Magnetite: occurs as small scattered grains associated with the muscovite.

About two miles to the north-east of the townsite are a few small outcrops of what is apparently a large body of granite extending northward from this point to the neighbourhood of Munarra Gully; the greater part of this belt is covered by a considerable thickness of recent deposits, but where found outcropping it is seen to be a coarse-grained variety exactly similar in appearance to that outcropping near G.M.L. 146, and a description of a section which is given above. The junction between this granite and the greenstones is for the most part hidden by the recent deposits, but it appears that the granite is newer than and intrusive into the greenstones.

Some seven or eight miles to the east of the town is another large body of granite; this belt runs approximately north and south, and is of a similar type to the above.

SUPERFICIAL DEPOSITS.

Covering the greater part of the district is a considerable thickness of recent deposits; these vary in depth from a few inches to many feet, and are derived from the gradual denudation of the older rocks, and consist for the most part of a loose, red, somewhat sandy soil.

In addition to these deposits there are a few small areas of ironstone gravel; these occur as the cappings of greenstone ridges, but are of very poor quality and of very limited extent; they are found principally in the neighbourhood of the Bachelor G.M., and beyond the eastern extension of the map.

THE REEFS.

The majority of the reefs being worked in this district are those found occurring in connection with the quartzites. They are generally of white quartz, often sugary near the surface, and vary greatly both in size and in their gold contents, a reef often ranging from a mere thread to as much as 10 feet and more in the same workings. They usually run close alongside the quartzite bars, and at the points where they come in actual contact with the latter generally carry rich chutes of gold. These chutes, though often exceedingly rich, are small and very irregular in their occurrence, and the bulk of the stone between them is, as a rule, very low grade. These quartz reefs are of later formation than the quartzites, and are often found cutting across them; in such cases rich chutes of gold are usually obtained at the points of intersection.

Several reefs are being worked which occur in the greenstones at some distance from the quartzites. These are, as a rule, somewhat smaller, but are much more regular and more defined than the preceding type; their gold contents too are more uniform, and, on the whole, they are a much more promising class of reef.

A considerable amount of alluvial gold has been obtained from a spot about half-a-mile to the north of the townsite. This "patch" was about half-a-mile in length and from five to ten chains in width, and is situated on the side of a ridge along which a number of quartzite bars outcrop. The gold has probably been derived from a number of small quartz leaders and stringers associated with these bars, and was all found at a depth of only a few inches from the surface. At the present time this patch appears to be pretty well worked out.

WATER.

This district is well watered, and abundance of good fresh water is obtainable by sinking to a depth of about 80 feet.

TIMBER.

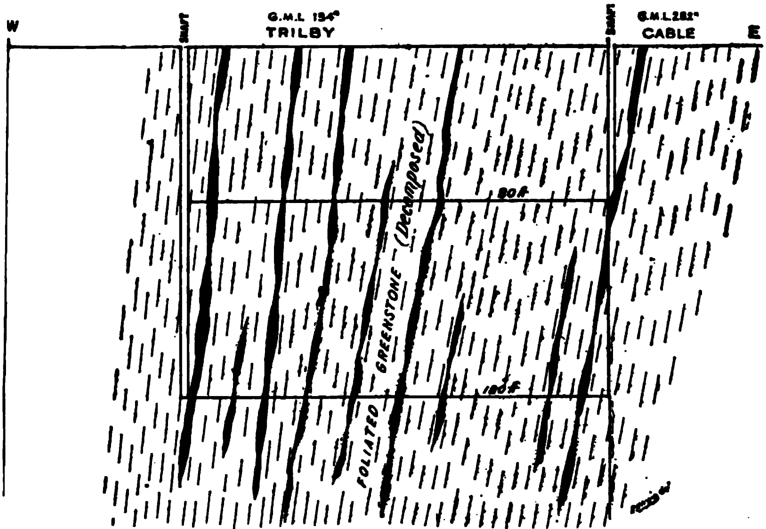
The only timber available for mining purposes and for fuel is mulga, and this is rapidly becoming very scarce in the near neighbourhood of the town, and most of the timber used has to be carted in from considerable distances.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit:—

TRILBY G.M.L. 1132.—A good deal of work has been done on this property, though very little was going on at the time of my visit. The main shaft has been sunk vertically to a depth of 200 feet, and levels have been put in along the reef at 80 and 180 feet southerly to the south boundary of the lease, and northerly for a distance of 400 feet; a good deal of stoping has been done from these levels, all the stone above water being taken out, and crosscuts have been put in easterly for about 200 feet at both levels with the purpose of cutting parallel reefs; not much work, however, has been done on these. (Fig. 2.)

Fig. 2.



Horizontal Scale 2½ Chains to 1 inch   Vertical Scale 100 feet to 1 inch

CROSS SECTION OF REEFS AT TRILBY MAIN SHAFT. TUCKANARRA.

The main line of reef, which can be followed through this and the adjoining leases for some distance, is somewhat irregular in size, varying from one to six feet, and dips steeply to the westward, striking about north-north-west and south-south-east. Several smaller reefs run alongside the main one and further to the eastward, but as far as tested were very irregular both in size and in their gold contents, and, generally speaking, were very poor below water. Several shafts have been sunk to water on one of these eastern reefs, but very little work has been done from them, and they are now practically abandoned.

The country is a fine-grained greenstone, very soft and decomposed down as far as worked, and intersected by several small diorite (?) dykes, which run east and west and cut through the reefs without displacing them in any way.

An abundant supply of fresh water was struck at about 90 feet.

Blue Anchor G.M.Ls. 1190, etc.—This property adjoins the Trilby immediately on the north, the workings being situated on the same line of reef. Several shafts have been sunk, the deepest to a vertical depth of 150 feet. From this shaft drives have been put in southerly along the reef at 70 and 150 feet, that at the 70-feet level for a distance of about 600 feet, and the whole of the reef for this length stoped out to the surface; that at the 150 feet has been put in 400 feet, and this block stoped out up to the 70-feet level. Very little work has been done to the north of the main shaft. The reef, as was the case in the Trilby, is very irregular both in size and in its gold contents, varying from a few inches to as much as 10 feet, the large bunches being, as a rule, very low grade; in the upper workings it is running very nearly vertically, but at water level it is dipping at a steep angle to the westward; near the main shaft it is crossed by a small granite dyke running east and west, and dipping at a very flat angle to the south; this dyke, however, does not displace it in any way.

The country is greenstone, and is very decomposed and rotten as far as opened up.

Abundance of fresh water was struck at 75 feet.

At the time of my visit (October, 1903) no work was being done on this property.

ANCHOR CONSOLIDATED G.M., LTD., G.M.Ls. 1182, 1190, 1197, 1203, 1205.

—	Tons of ore treated.	Ozs. of gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	...	...	...
1897	29·50	26·55	·90
1898	...	...	...
1899	254·00	297·00	1·17
1900	710·00	812·50	1·14
1901	3,837·00	3,028·37	·78
1902	2,201·00	1,934·40	·88
1903	40·00	* 80·25	...
Total ...	**7,071·50**	**6,179·07**	**·87**

* Includes 75ozs. by cyanide.

TRILBY No. 1 G.M.L. 1196.—This block adjoins the Trilby immediately on the south, and the workings are on the same lines of reef as have been worked on that property. Four shafts have been sunk to water level (90 feet) near the north boundary of the lease, and the three most westerly connected by a crosscut at this level. Two reefs were driven on southerly at water level for a distance of about 50 feet; these varied in size from six inches to two feet, but were very low grade, and no further work was done on them.

TRILBY No. 1 G.M.L. 1196.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	7·50	1·40	·19
1902	21·00	1·50	·07
1903	20·00	7·85	·39
Total ...	**48·50**	**10·75**	**·22**

Cable G.M.L. 1199.—Near the eastern boundary of this lease a large irregular quartz reef is being worked, varying in size from three to 12 feet, and consisting of a sugary ironstained quartz. Its general trend is about north and south, but near the main shaft it takes a sharp turn to the eastward for about 100 feet, and then gradually comes round to its north course again; it dips at a steep angle to the westward. The chute of gold is about 250 feet in length, and dips to the southward, but the values of the reef vary considerably within this length. The country is very broken and decomposed down as far as worked.

The main shaft has been sunk on the reef to a depth of 100 feet (water level), and drives put in along it at this level for 100 feet southerly and 160 feet northerly; very little stoping has been done. The reef is about 12 feet wide at the end of the south drive, but is much smaller and more broken at the north end. Near the western boundary a reef parallel to the Trilby line has been worked to a depth of 80 feet. This reef is from one to eight feet in width, averaging about three feet, and dips westerly, dipping into the Trilby lease at about 80 feet. It has been worked out from this level to the surface for a distance of 110 feet south, and 60 feet north in the Cable. Crosscuts have also been put into it from the Trilby main shaft at the 80 feet and 180 feet levels, and a little work was done on it at this latter level, but the stone had become very poor, and it was soon abandoned.

CABLE G.M.L. 1199.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	65·50	73·53	1·12
1901	111·00	108·10	·97
1902	405·10	321·29	·79
1903	1,312·00	802·27	·61
Total ...	**1,893·60**	**1,305·19**	**·69**

Open Cut G.M.L. 1218.—The same reef is being worked on this property as on the Cable. It is here running north and south, and an open cut has been made on it to a depth of about 40 feet. A vertical shaft has also been sunk on it to a depth of 95 feet, and a drive put in southerly for 100 feet along it at this level, and a little stoping done. The reef, which dips west at an angle of about 80°, as seen in the drive, is very irregular and broken, varying in size from three to 12 feet. Its gold contents, too, vary greatly, the stone as a whole being low grade, with occasional small rich patches.

A crosscut has been put in easterly from the shaft at the bottom level, for a distance of about 60 feet, with the object of cutting a second parallel reef which outcrops about a chain to the east.

TRILBY, BLOCK I, G.M.L. 1218 (OPEN CUT).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	104·50	74·65	·71
1901	28·00	5·40	·19
1902	...	...	...
1903	...	...	...
Total ...	132·50	80·05	·60

LADY EVA G.M.L. 1180.—This property is situated about two miles east of Tuckanarra township. A large white quartz reef runs through about the centre of the lease on the western side of a large felsite dyke running north-west and south-east. It has no defined course, but twists about in all directions. Three shafts have been sunk on it, the deepest being down 70 feet, and the other two 40 and 20 feet. About 60 feet of driving has been done from the 70 feet shaft, but no stoping. The reef, as opened up here, is from four to six feet wide. The greater part of the stone is of very low grade, but a few rich pockets were obtained, principally along the junction of the reef with the dyke. At the time of my visit a little work of a prospecting nature was being carried on near the surface.

The country is greenstone, considerably foliated, and getting very hard almost at the surface.

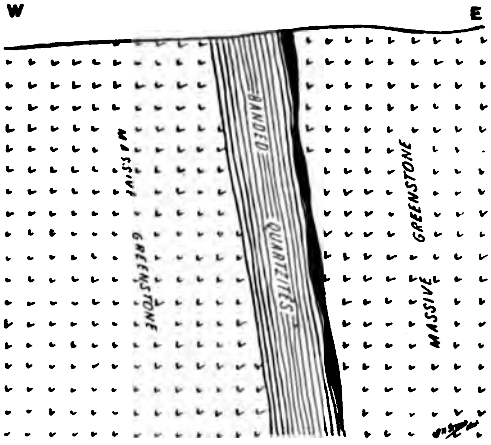
LADY EVA G.M.L. 1180 (109N).

Year.	Gold.
1897	70·85oz. dollied and specimens.
1898	19·90 oz. „ „
Total	90·75 oz. „ „

BOYD'S REWARD, R.C. 64N.—A fair-sized quartz reef runs along the eastern side of a large quartzite bar running about north-west and south-east near the western boundary of this lease. This reef, which varies in size from six inches to three feet, and dips with the bar (Fig. 3) at a steep angle to the eastward, has been worked down to a depth of about 90 feet. Several shafts have been sunk on it to this depth, and a block 200 feet in length has been stoped out from this level to within about 30 feet of the surface.

A main vertical shaft has been sunk to a depth of 200 feet a little to the east, and crosscuts put in to intersect the reef at 140 and 180 feet, but no further work has been done from it, and at the time of my visit the workings were full of water.

Fig. 3



SECTION SHEWING THE MODE OF OCCURRENCE OF REEF ON BOYDS REWARD G.M L 64 TUCKANARRA.

The reef is very patchy, the gold occurring in small, short chutes, or pockets, some of which were phenomenally rich.

The country, as far as worked, consists of very soft, decomposed greenstone.

A plentiful supply of fresh water was struck at about 95 feet.

Boyd's Reward, R.Cs. 341, 342 (R.C. 64n).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1899	210·50	3,245·44	15·41
1900	345·00	*697·30	2·02
1901	156·00	242·30	1·55
1902	33·00	377·65	11·44
1903	91·00	178·45	1·96
Total	835·50	4,741·14	5·67

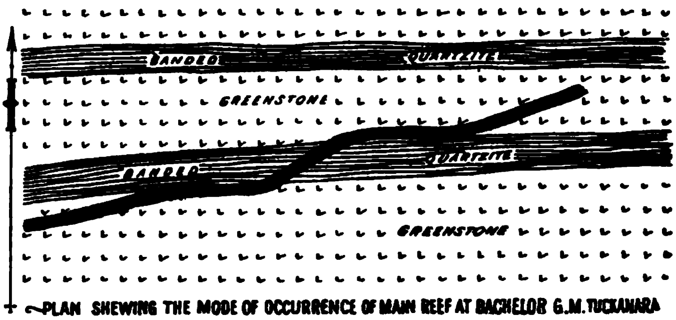
* Includes 34·65oz. dollied and specimens.

Nemesis G.M.L. 1337 (late **Bachelor**).—This property is situated about six miles to the east of Tuckanarra townsite.

Several quartzite bars run through the lease on a bearing slightly north of east and south of west. A small irregular quartz reef and several small quartz leaders run alongside and across one

of these bars. This reef has been worked to a depth of 100 feet by means of two vertical shafts, from the most western of which drives have been put in along the reef for 150 feet east and 80 feet west at both the 50 and 90 feet, but practically no stoping has been done. The reef varies in thickness from a few inches to about three feet, and is very irregular in its gold contents; a very rich chute was obtained at the point where it crosses the quartzite bar (Fig. 4) and has been worked out from water level (100 feet) to the surface.

Fig. 4.



PLAN SHEWING THE MODE OF OCCURRENCE OF MAIN REEF AT BACHELOR G.M. TUCKANARA

Several other parallel reefs run through the property, and, doubtless, similar rich chutes will be found in these at their points of intersection with the quartzites.

The quartzites carry a fair percentage of pyrites below water level as well as a small amount of gold.

Several other leases have been pegged out along this line of reef, but, so far, practically no work has been done upon them.

The country is greenstone, very soft as far as opened up.

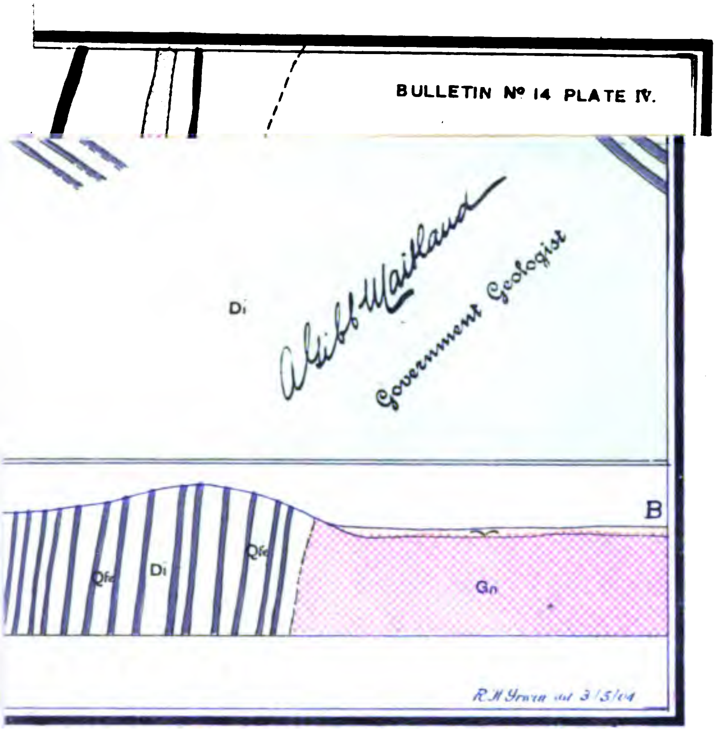
Good fresh water is met with at 100 feet.

NEMESIS G.M.L. 1337 (late BACHELOR G.M.L. 1192)

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	34·00	*143·10	4·21
1901	38·00	100·45	2·64
1902	58·00	70·75	1·22
1903	236·00	775·03	3·28
Total ...	**366·00**	**1,089·33**	**2·98**

* Includes 24·65 oz. dollied and specimens.

BULLETIN Nº 14 PLATE IV.



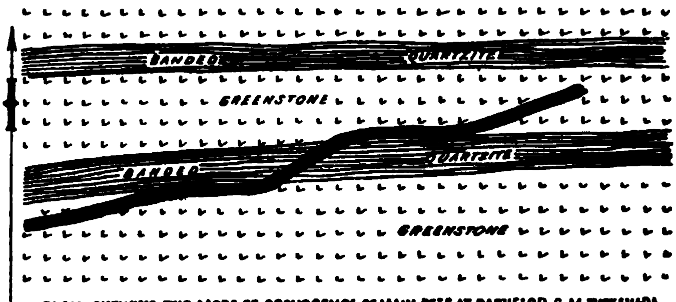
A Gibb Maitland
Government Geologist

R.H. Green del 3/5/04

H J. Pether. Government Photolithographer, Perth, W.A.

of these bars. This reef has been worked to a depth of 100 feet by means of two vertical shafts, from the most western of which drives have been put in along the reef for 150 feet east and 80 feet west at both the 50 and 90 feet, but practically no stoping has been done. The reef varies in thickness from a few inches to about three feet, and is very irregular in its gold contents; a very rich chute was obtained at the point where it crosses the quartzite bar (Fig. 4) and has been worked out from water level (100 feet) to the surface.

Fig. 4.



PLAN SHEWING THE MODE OF OCCURRENCE OF MAIN REEF AT BACHELOR G.M. TUCKANARA

Several other parallel reefs run through the property, and, doubtless, similar rich chutes will be found in these at their points of intersection with the quartzites.

The quartzites carry a fair percentage of pyrites below water level as well as a small amount of gold.

Several other leases have been pegged out along this line of reef, but, so far, practically no work has been done upon them.

The country is greenstone, very soft as far as opened up.

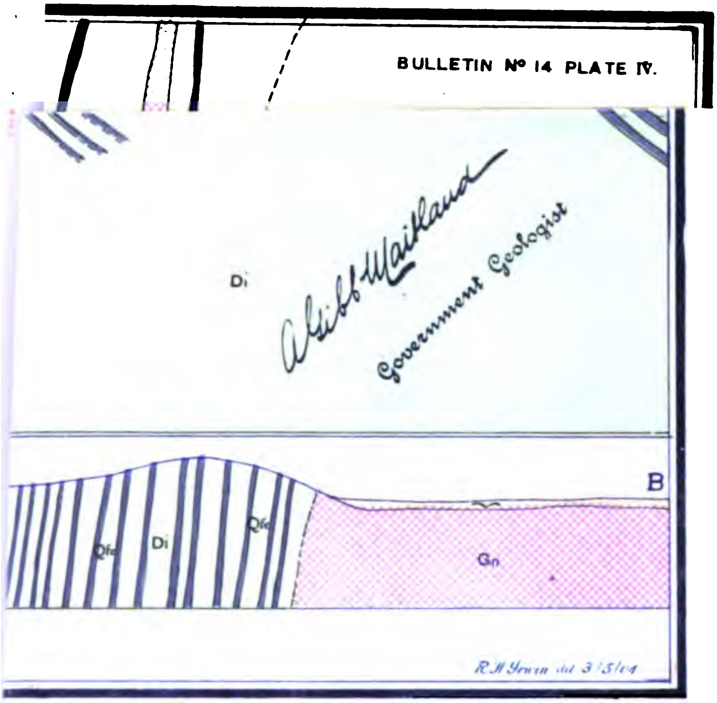
Good fresh water is met with at 100 feet.

Nemesis G.M.L. 1337 (late Bachelor G.M.L. 1192)

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	34·00	*143·10	4·21
1901	38·00	100·45	2·64
1902	58·00	70·75	1·22
1903	236·00	775·03	3·28
Total ...	366·00	1,089·33	2·98

Includes 24·65 oz. dollied and specimens.

BULLETIN No 14 PLATE IV.



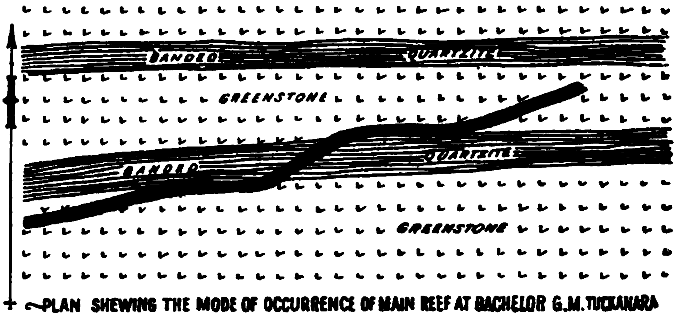
A Gibb Maitland
Government Geologist

R.H. Irwin del 3/5/04

H J. Pether. Government Photolithographer. Perth, W.A.

of these bars. This reef has been worked to a depth of 100 feet by means of two vertical shafts, from the most western of which drives have been put in along the reef for 150 feet east and 80 feet west at both the 50 and 90 feet, but practically no stoping has been done. The reef varies in thickness from a few inches to about three feet, and is very irregular in its gold contents; a very rich chute was obtained at the point where it crosses the quartzite bar (Fig. 4) and has been worked out from water level (100 feet) to the surface.

FIG. 4.



PLAN SHEWING THE MODE OF OCCURRENCE OF MAIN REEF AT BACHELOR G.M. TUCKANARA

Several other parallel reefs run through the property, and, doubtless, similar rich chutes will be found in these at their points of intersection with the quartzites.

The quartzites carry a fair percentage of pyrites below water level as well as a small amount of gold.

Several other leases have been pegged out along this line of reef, but, so far, practically no work has been done upon them.

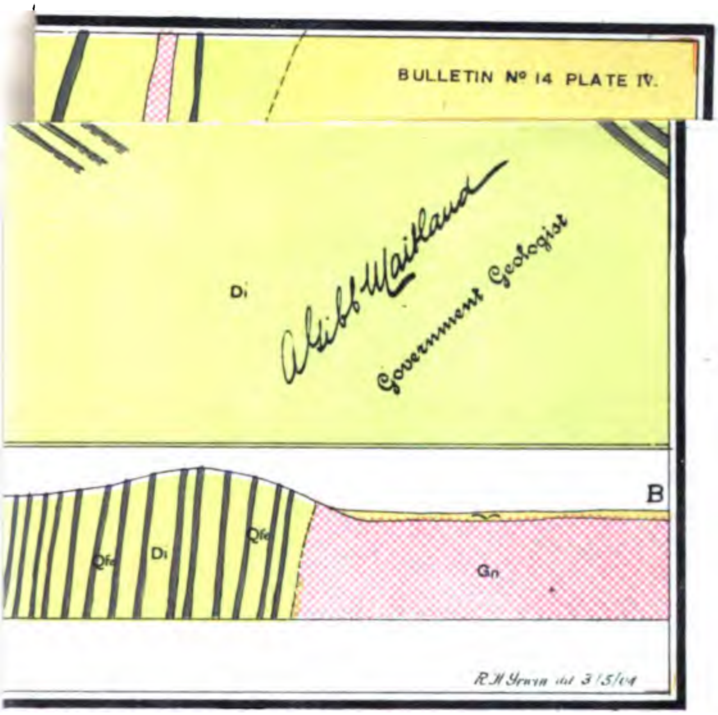
The country is greenstone, very soft as far as opened up.

Good fresh water is met with at 100 feet.

NEMESIS G.M.L. 1337 (late BACHELOR G.M.L. 1192)

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	34·00	*143·10	4·21
1901	38·00	100·45	2·64
1902	58·00	70·75	1·22
1903	236·00	775·03	3·28
Total ...	366·00	1,089·33	2·98

* Includes 24·65 oz. dollied and specimens.



A Gibb Maitland
Government Geologist

R.H. Irwin del 3/5/04

H. J. Pether. Government Photolithographer. Perth, W.A.

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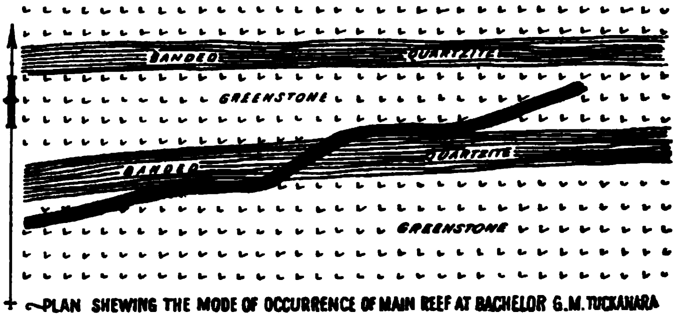
FIG. 4.



PLAN SHEWING THE MODE OF OCCURRENCE OF MAIN REEF AT BACHELOR G.M. TUCKANARA

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The country is greenstone, very soft as far as opened up.

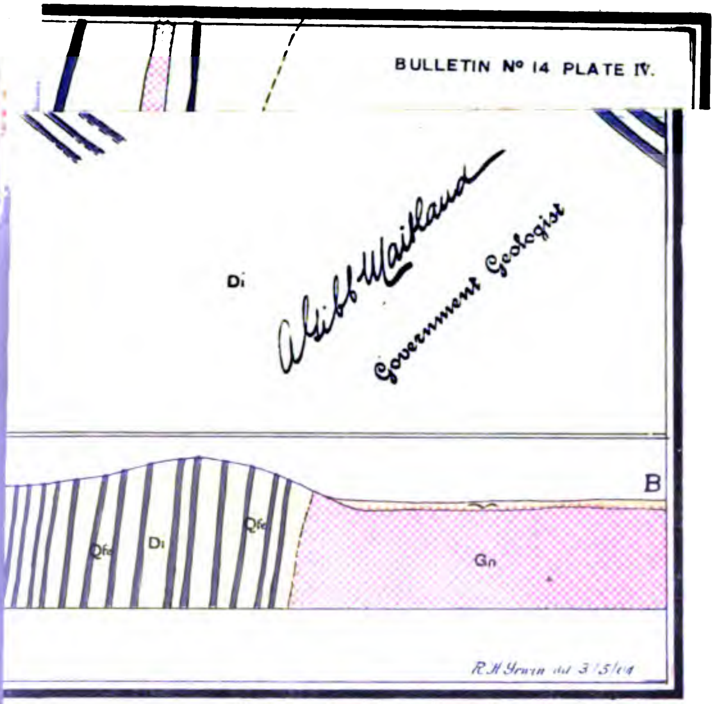
Good fresh water is met with at 100 feet.

NEMESIS G.M.L. 1337 (late BACHELOR G.M.L. 1192).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1900	34·00	*143·10	4·21
1901	38·00	100·45	2·64
1902	58·00	70·75	1·22
1903	236·00	775·03	3·28
Total ...	**366·00**	**1,089·33**	**2·98**

Includes 24·65 ozs. dollied and specimens.

BULLETIN No 14 PLATE IV.



A Gibb Maitland
Government Geologist

R. H. Irwin del 3/5/04

H. J. Pether, Government Photolithographer, Perth, W.A.

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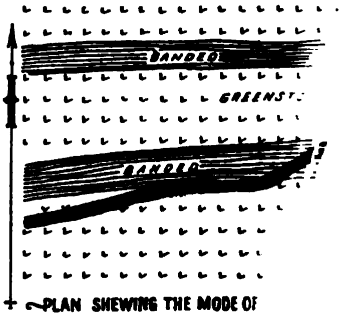

PLAN SHEWING THE MODE OF

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Includes 24·65 oz. dollied and specimens.

The following table shows the total gold returns from the leases at Tuckanarra, other than those already mentioned, up to the end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Bright Smile	1396	23·00	10·50	·46
Diorite Queen	1225	39·00	22·30	·57
Douglas Boulder	1280 (199N)	137·50	*629·67	4·51
Dyke	1242	83·50	18·80	·22
East Lynne	1223 (131N)	27·00	10·14	·39
Federal	1349	119·00	14·60	·12
General Gordon	1285	10·00	34·00	3·40
Just-in-time	1378	15·00	3·65	·24
Maybelle	1363	181·00	41·20	·23
Newhaven	1200 (287N)	57·00	†165·09	2·89
No. 1 South Tuckanarra	1191 (223N)	160·00	50·00	·31
Rand	1226	10·00	62·50	6·25
Tuckanarra North	1185 (206N)	143·00	40·10	·28
(W. Dowson)	P.A. 599	24·00	14·70	·61
Sundry Claims	...	313·15	70·57	·22
Treated at Public Battery	...	...	‡589·40	...

* Includes 465·12oz. dollied and specimens.
† „ 118·95oz. „ „
‡ By cyanide.

The Country between Tuckanarra and Munarra Gully.

From Tuckanarra northwards the country is greenstone, traversed by hæmatite-bearing quartzites, to a point about a mile north of the Trilby G.M., where granite makes its appearance, continuing mostly as level plains covered with loose sandy soil, with bare outcrops of rock here and there, to a spot about a mile south of Munarra Gully, where it once more disappears below the greenstones. The northern boundary of this granite belt runs easterly nearly as far as Stake Well, and westerly for eight or ten miles, then turning away north. The country in the neighbourhood of Munarra Gully is hilly, and consists of massive fine and coarse-grained greenstone. The belt is some 15 miles across, and runs in a general northerly direction from this point. Its eastern extension includes Stake Well, at which point the greenstones are traversed by a series of north and south belts of hæmatite-bearing quartzites, similar to those occurring at Tuckanarra, Nannine, Boogardie, and other places on the Murchison goldfield. These belts run in an almost due north and south direction, and have been proved to extend northerly for at least 10 miles. Stake Well is about their southern limit.

After Many Years G.M.Ls. 23CN, 231N, etc.—These leases are situated at Munarra Gully, about nine miles north of Tuckanarra; a large quartz reef runs east and west through them, and a good deal of work has been done on it down to a depth of 300 feet on the underlay (90 feet vertical). The reef, which is rather bunchy, runs up to 10 and 12 feet in width, averaging about six feet, and dips at an angle of from 30° to 40° to the north; it carries a large percentage of pyrites at water level and a considerable quantity of oxide of iron, resulting from the oxidation of the pyrites, above water level. A good deal of copper is also associated with it; this, which is mostly in the form of malachite (green carbonate), occurs usually in bunches, some of which were very rich. A little sulphide ore is beginning to make its appearance at water level, at which depth the reef is lying much flatter than at the surface. At a point some five chains west of the main shaft the reef takes an "S" curve for a few chains and then runs on again on its original bearing; at this point a vertical shaft has been put down to a depth of 75 feet, and a little driving and stoping done from it. Eastward from the main shaft the reef is very poor, and practically no work has been done on it in this direction. The best stone was obtained near the surface from a large open cut about a chain west of the main shaft. In this shaft the reef pinches out at a point about 100 feet from the surface (on the underlay), but makes again a few feet further down, and in the bottom level is from eight to ten feet in width, with clean, well-defined walls, and giving every promise of living to a much greater depth. The main shaft has been sunk on the underlay to a depth of about 320 feet (90 feet vertical) to water. Levels have been put in at 80 feet for a distance of 300 feet west and 50 feet east, and at 300 feet for 300 feet west; a little stoping has been done between the 80 feet level and the surface, but none at the bottom level. These workings were carried out by the original company, and are now abandoned, and the leases have recently been repegged by a new syndicate, who are erecting a five-head battery at the eastern end of the reef, and are carrying on work in a small way both at this point and at the extreme western end of the reef, where an underlay shaft has been sunk to a depth of about 40 feet, and a little driving and stoping done from it. The reef here is low grade and is very irregular, varying from a few inches to as much as four feet.

At the eastern end of the line what appears to be a parallel reef has been worked to a depth of about 40 feet, partly by the original company and partly by the present owners; a considerable quantity of fairly rich stone was taken out of a large open cut by the original owners, and a water shaft sunk to a depth of about 60 feet. The present syndicate are now working this reef at a depth of about 40 feet; it is low grade—being expected to average about seven dwts.—and very irregular, varying from a mere thread to as much as six feet.

An abundant supply of good fresh water is obtained at about) feet vertical in the main workings and at about 50 feet on the wer country.

The country consists of massive fine and coarse-grained green-one, and gets very hard and settled at about 75 feet.

After Many Years G.M.Ls. 230/1N, 265/6N, 314N, 322N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1900	11,321·00	5,727·73	·50
1901	...	* 88·00	...
1902	168·00	175·80	1·04
1903	12·75	15·00	1·17
Total	11,501·75	6,006·53	·53

* By cyanide.

The Country between Munarra Gully and Quinns.

(Thirty-one miles E.)

The road from Munarra Gully to Quinns for the first mile runs south, over greenstone ridges, till it comes on to the granite country; it then turns easterly and runs over granite flats, close to their northern junction with the greenstones, to a spot a mile or two west of Stake Well, where the granite disappears and its place is taken by greenstone ridges traversed by north and south bands of hæmatite-bearing quartzites. The greenstones extend to within about half-a-mile of the railway line at Stake Well, when they give place to extensive flats covered with a considerable thickness of recent deposits, which apparently overlie greenstones, and heavily timbered with mulga, except in the near neighbourhood of Stake Well, where it has all been cut for firewood, etc. These flats continue uninterruptedly to Culculli, at which point there is an outcrop, in the form of a low ridge, of greenstones traversed by several small north and south quartzite bars; from here the flats continue again for a further distance of about three miles, at which point there is a large bare outcrop of granite extending for two or three miles, and apparently trending away north-east. From here the flats are continuous on past Burnakura—at which place there are a few low greenstone ridges—to a point about three miles west of Quinns, at which spot the country becomes hilly, and consists of massive greenstones traversed by several parallel quartzite bars, which run in the form of a rough semicircle round the Quinns townsite, and intersected by intrusive areas of granitic schists.

Quinns.

The mining centre of Quinns is situated about 35 miles to the east of Tuckanarra. Speaking of this district, Mr. Woodward, a former Government Geologist, says * :—

> At Quinns some low, rough ranges of metamorphic rock rise from the plain, which for a considerable distance from them is strewn with stones.

---

* The Murchison Goldfield, by H. P. Woodward, page 20, Perth. By Authority, 1893.

The reefs here are mostly large and very ferruginous; in fact, in some cases would be better described as iron lodes. These, of course, though consisting of hæmatite at the surface, will make into pyrites in depth, which will be more troublesome to work; therefore only those reefs which are very rich will be worth working after they cease to pay the prospectors to do so by hand.

Some of the gullies in these hills proved very rich in alluvial gold, and were easily worked, as the gold was found in a defined gutter, but up to the present no reefs along these gullies have been found which were rich enough to work.

The Sir Garnet is a large lode, mostly composed of hæmatite, in which there are some bunches of quartz which show gold freely. This hæmatite is the result of the decomposition of sulphides, which will be met with in depth. Considering the richness of the stone, length of outcrop, and size of the lode, this mine should pay.

The Premier is also on a large ironstone lode, but seems to carry the gold only in small veins, on the extent of which will depend the value of this mine.

There are several other reefs being prospected, but on these very little can be said at present.

At Quinns there is a small area of granitic schists occurring entirely within the greenstones and from a mile to a mile and a-half in width and three miles or so in length, forming a series of low, rough ridges, rising to a height of 50 feet or 60 feet above the plain, and in about the centre of which the townsite of Quinns is situated. The rock itself, which appears to be a very highly foliated granite, is very much weathered and decomposed; a section (464) of a specimen [5333] taken from G.M.L. 467, seen under the microscope, shows it to consist of—

(*a.*) Quartz: abundant, in irregular grains and imperfectly formed crystals.

(*b.*) Felspar: also very abundant, in large irregular lumps and tabular crystals; it is probably principally oligoclase, but is very clouded and decomposed.

(*c.*) Biotite: fairly plentiful, in long, ragged flakes considerably altered and bleached.

Most of the present workings are situated in these schists, near their western end.

The schists are surrounded by greenstone ridges extending outwards for several miles, when they die out and give place to level plains covered with recent deposits. These greenstones are very much decomposed and weathered on the surface, and consist for the most part of a coarse-grained diorite, a section (463) of a specimen [5329] of which, taken from a point five chains north of G.M.L. 453, seen under the microscope shows it to consist of—

(*a.*) Hornblende: comprising about 50 per cent. of the section, and occurring in the form of small lath-shaped crystals and irregularly-shaped plates and grains; it is considerably chloritised in places.

(*b.*) Felspar: forming the greater part of the remainder of the section, and in the form of small grains and lumps, for the most part without any signs of crystalline boundaries; it is probably principally oligoclase, but is much clouded and considerably decomposed.

(*c.*) Magnetite: fairly plentiful in scattered grains throughout the section.

A few small crystals of apatite are also present, as well as a little calcite in irregular grains.

The rock is somewhat weathered, and shows slight signs of foliation; this, however, may only be the result of the weathering.

These greenstones are traversed by parallel bands of hæmatite-bearing quartzites of the usual type, which run, roughly, parallel to the junction of the greenstones with the schists, and form rough ridges 50 to 70 feet high. In one or two instances they have been worked for their gold contents, but not much work was done on them, and they have since been abandoned.

A partial analysis made in the Departmental Laboratory of a typical sample [**5331**] of these quartzites, taken from the Sir Garnet G.M.L. 23, gave results as follows:—

Metallic iron	29·63	per cent.
Silica	54·15	„
Phosphorus	·073	„
Sulphur	·034	„
Hygroscopic water	·08	,
Combined water	·60	„

THE REEFS.

These occur both in the greenstones and in the schists, most of those in the greenstones being found occurring in conjunction with the quartzites, although several large ones are found outcropping at some distance from them; these, however, are apparently no good, and no work has been done on them. At present all the workings in the greenstones have been abandoned, and the only reefs being worked are those occurring in the schists. These have a general trend about north-east and south-west, and though not large are very regular and well defined, with every promise of living to a considerable depth. The district is considerably handicapped owing to the fact that there is no battery nearer than Gabanintha—10 miles. A large amount of alluvial gold has been obtained from this field in past years, both over the greenstone country and the schists. Where found over the former, it appears to have been derived principally from numerous small quartz reefs and veins associated with the quartzites; while in the schists it is probably derived from small quartz leaders which run through them in all directions, and some of which are very rich.

Very little alluvial work is being done on the field at present.

WATER.

Fresh water is obtainable on the field at a depth of from 50 to 70 feet, and is apparently present in fair quantity.

TIMBER.

Timber (mulga) is still fairly plentiful throughout the district.

The Mines.

TWO JACKS REWARD LEASE 453N.—A fair-sized quartz reef runs on an approximately north-east and south-west bearing through this lease near its north-western boundary. The reef has a well-defined outcrop, and can be followed for a considerable distance through this lease and the adjoining one. On it two shafts have been sunk—the most westerly to water level (80 feet), and the easterly to a depth of 50 feet. From the former of these, drives have been put in 20 feet east and 30 feet west at water level, but no stoping has been done. In this shaft the reef is six feet wide at the surface, 18 inches at 40 feet, and four feet at water level, and consists of white laminated quartz. The second shaft is down 50 feet underlay on the reef, and a block about 25 feet in length has been stoped out each way from this level to close to the surface. The reef, as shown here, is about five feet wide in the west face and three feet in the east, its average width throughout being about four feet, and dips at an angle of about 80° to the south; the walls are very clean and well defined right from the surface.

The country consists of granitic schist, and is fairly soft as far as opened up.

Good fresh water was struck at a depth of about 80 feet.

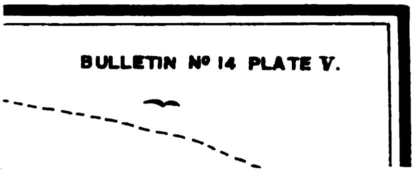
A second reef runs through the property nearly parallel to the main line, a couple of chains farther north. This is a fair-sized, nice-looking reef on the surface, but so far no work has been done on it.

Up to the end of 1903, 215·00 tons of stone had been crushed from this mine for a yield of 217·77ozs., including 22·02ozs. dollied and specimens, giving an average of ·99oz. per ton.

On the adjoining lease, on the west, a little work has been done on the same line of reef, which is here about six feet in width, and 10 tons of surface stone were crushed for an average yield of 10dwts.

CORNSTALK G.M.L. 465N.—The reef on this property runs about north-east and south-west; on it a shaft has been sunk to a depth of 35 feet, and a few tons of stone stoped out; an open cut has also been made on the reef a few chains south-west from the shaft to a depth of about 20 feet. The reef, which consists of clean, white laminated quartz, is about 12 inches in thickness at the top of the shaft, widening to about two feet at the bottom; in the open cut it is about three feet, and dips to the south-east at an angle of about 75°; the richest stone so far has all been found on the footwall side of it, that on the hanging wall being as a rule poor, especially where the reef widens. The country is granitic schist considerably omposed and softened, but the walls of the reef are very clean well defined right from the surface.

BULLETIN Nº 14 PLATE V.



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During 1903 this property crushed 81·00 tons of stone for 62·15ozs. of gold, being at the rate of ·76oz. per ton.

PRINCESS DAGMAR G.M.L. 478N.—This lease adjoins the Cornstalk on the south-west, and is working on the same line of reef; a vertical shaft has been put down on it to a depth of 50 feet (water level), and about 30 feet of driving and a little stoping have been done at this level. As far as opened up, the reef is about three feet in thickness, and consists of clean, white laminated quartz, as in the Cornstalk; it dips at an angle of about 80° to the south-east. Good water was struck at 50 feet, at which level the reef is some four feet in width, and appears to be improving in value. The country is fairly soft granitic schist, and the walls of the reef, as in the Cornstalk, are clean and sharp right from the surface. To the end of 1903 this mine has crushed 58·50 tons for 42·10ozs., an average of ·72oz. per ton.

HOMESTAKE G.M.L. 467N.—Several lines of reef run through this property in the prevailing north-east and south-west direction. On the most northerly of them a fair amount of work appears to have been done, but it is now abandoned. On the reef at present being worked a couple of shafts have been put down to a depth of about 30 feet, but no driving or stoping has been done. The reef as exposed in these shafts is slightly bunchy, varying from 12 to 30 inches, and dips steeply to the south-east; it consists of clean, white laminated quartz, and has clean, well-defined walls. The country is granitic schist. So far, 25 tons of stone have been crushed for an average of 10dwts.

YORKSHIRE LASS G.M.L. 479N.—The workings on this lease are on the same reef as the Homestake workings. The only work done so far consists of an open cut from 10 to 15 feet deep, and some 40 feet in length; the reef, which has the same appearance as in the Homestake, is here from two to three feet in width, and dips to the south-east. The best stone is at present being got on the footwall side of the reef. During 1903, 17·50 tons of stone were crushed from this lease for a yield of 3·15ozs., an average of ·18oz. per ton.

The following table shows the total gold returns from the leases at Quinns, other than those already mentioned, up to the end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
Joe Chamberlain ...	469N	20·00	8·40	·42
Manchester	214N	...	* 17·37	...
Nowthanna	420N	567·00	† 517·55	·91
(Grant and Davis) ...	L.C. 49	...	* 164·15	...
Sundry claims	...	...	* 103·03	...

* Dollied and specimens. † Includes 17·25ozs. dollied and specimens.

The Country between Quinns, Gabanintha, and Nannine.

(Ten miles north, then 20 miles west.)

For the first mile or so out of Quinns, towards Gabanintha, the country consists of low greenstone ridges, which gradually die out and give place to extensive level plains covered with a varying thickness of recent deposits; these continue to Star of the East, where the greenstones again outcrop, continuing as low ridges on past Gabanintha, where they are intersected by several large areas of intrusive granite. About halfway between Star of the East and Gabanintha is a ridge of almost pure hæmatite and magnetite, running about north and south. This ridge is from one to two chains wide, and extends for several miles. It appears to be of similar origin to the hæmatite-bearing quartzites of Tuckanarra, Nannine, etc.

From Star of the East the plains continue right to Nannine, with the exception of one break at a spot about six miles from the former place, where there is a fairly large greenstone and quartzite ridge similar to those occurring at Nannine, running about north and south. At Nannine there are a series of greenstone and quartzite ridges of the prevailing type, extending in a general north and south direction; beyond these, to the westward, the granite again outcrops, and extends in that direction indefinitely.

Gabanintha and Star of the East.

The mining centre of Gabanintha is situated about ten miles to the north of Quinns and some twenty-one miles east of Nannine. In the neighbourhood of the townsite the country consists of low rough greenstone ridges, extending southerly and westerly for about three miles, when they give place to extensive flats covered with recent deposits. Northerly they extend for some miles, and easterly for about half-a-mile when they are replaced by level granite country extending easterly for two or three miles, when greenstone ridges again come in, extending for a further three or four miles, when they are once more replaced by a large belt of granite running about north and south.

Some two miles to the north-east of the townsite of Gabanintha is situated Mount Yagahong; this is an almost flat-topped hill rising to a height of some 300 feet above the surrounding plains, and having, on the southern side, vertical cliff faces for about one hundred feet from the top. It consists of horizontally bedded basic tuffs which are well seen in the cliff faces, where they appear as a fine grained rock closely resembling a slate in appearance, the rocks on the top of the hill being coarser grained. A section (473) of a specimen [5334] taken from a few feet from the top, and seen under the microscope, shows it to be a fragmental rock consisting principally of broken crystals of felspar (plagioclase) showing very w signs of alteration; in addition to the felspar there are numerous small crystals of colourless augite and minute flakes of pale green hornblende considerably chloritised; small crystals of magnetite are also present, and one or two inclusions of rock fragments as well as a considerable amount of colourless glass.

These tuffs overlie the granite. A few miles to the eastward are one or two other hills exactly similar in appearance to Mt. Yagahong; these also are probably composed of similar bedded tuffs.

THE GREENSTONES.

The greenstones, which are the staple formation at Gabanintha, are for the most part massive, showing only slight signs of foliation in one or two places, except close to their junction with the intrusive granite, where there is considerable local foliation; they are as a rule a fine grained variety, and consist of diorite, amphibolite, and more or less altered forms of the former. A section (465) of a specimen [5336] taken from the Sovereign G.M.L., seen under the microscope, shows it to be a fine-grained, slightly foliated rock, consisting of—

(*a*.) Felspar (plagioclase): occurring in imperfectly formed crystals and plates; it is probably principally labradorite, and is considerably clouded from the presence of decomposition products.

(*b*.) Hornblende: very abundant, in irregular flakes, grains, and crystals; it is principally a pale green variety, and appears in places to be an alteration product of colourless augite. A green chloritoid substance is also present, evidently an alteration product of aggregates of hornblende crystals. A few small scattered grains of magnetite also occur.

THE GRANITES.

Intruded into the greenstones are large masses and dykes of granite; the main mass of this starts about half-a-mile east of the townsite, and extends easterly for three or four miles, southerly for about a mile, and northerly indefinitely; numerous small dykes also intersect the greenstones in close proximity to this mass, especially on the eastern side, and are evidently offshoots from it. Another smaller intrusion of granite occurs about three-quarters of a mile to the south-east of Star of the East.

The greenstones are highly foliated near their junction with the granites, the foliation being always parallel to the junction line and extending over a width of from four to five chains.

The granite is always massive and entirely free from any schistose structure. The main body is a coarse-grained, somewhat pinkish variety, and in its mineral constitution approaches nearer to a granitite than a true granite.

A section (467) of a typical specimen [5345] of it, taken from a spot about 40 chains north-east of G.M.L. 32, shows it to consist essentially of quartz, felspar, and magnetite.

The quartz and felspar constitute about equal portions, occurring as irregular lumps and imperfectly formed crystals; there is also a little micrographic intergrowth of the two. The felspars, which are probably orthoclase, are considerably decomposed and clouded, and in parts much ironstained.

Magnetite is present in considerable quantity, and a good deal of it is in the form of skeleton crystals, which appear to result from the decomposition of biotite or hornblende.

A little secondary calcite is present, as well as a few small scattered crystals of apatite.

The whole rock is considerably decomposed and weathered.

A second specimen [**5343**], taken from a small outcrop on G.M.L. 241, about three-quarters of a mile south-east of Star of the East, is somewhat similar, but is redder in colour and not so weathered; a section (466) of this rock shows it to be a granitite (granophyre) consisting, like the preceding, essentially of quartz, felspar, and magnetite. In this case the section shows a micrographic intergrowth of the quartz and felspar (flesh-coloured orthoclase) and regular crystalline aggregates of felspar fibres, as well as large irregular grains and crystals of quartz and phenocrysts of plagioclase (oligoclase). The felspars throughout are somewhat clouded and weathered. Magnetite is also plentiful in grains and imperfectly formed crystals. A little epidote, resulting from the alteration of the felspars, is also present in addition to a few small indefinite greenish particles, which probably represent the remains of minute flakes of biotite.

THE IRON ORES.*

About half way between Gabanintha and Star of the East is a low ridge consisting of almost pure hæmatite and magnetite, and extending on a bearing slightly west of north and east of south for about two and a-half miles; the belt of iron ore which forms this ridge is from one to two chains in width, and rises in places to a height of 50 feet or 60 feet above the surrounding country; it appears to be of similar origin to the hæmatite-bearing quartzites occurring so commonly throughout the district. There is a huge amount of iron ore of first class quality in this deposit, but its geographical position renders it practically valueless.

The following is a partial analysis made in the Departmental laboratory of a sample [**5344**] of this ore taken from a spot 40 chains E.N.E. of G.M.L., 241 Star Extended :—

Metallic iron	52·14	per cent.
Silica	·20	„
Phosphorus	·008	„
Sulphur	*nil*	„
Titanic oxide	12·68	„
Hygroscopic water	·15	„
Combined water	1·15	„

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* See page 81.

THE REEFS AND LODES.

These occur both in the greenstones and in the granite, those found in the latter being usually close to its junction with the greenstones, and consisting generally of very large white barren-looking quartz reefs outcropping for a considerable distance. In only one instance has a reef in the granite country been worked, viz., on G.M.L. 385, where a large quartz reef close to the greenstones, and running parallel to the junction, has been worked apparently to a depth of about 70 feet; evidently, however, it had not proved much good, and at the time of my visit had been abandoned for some time.

Some very large reefs are also found in the greenstones close to their junction with the granite, notably one about a quarter of a mile east of the townsite, which outcrops for about three-quarters of a mile and in places is over a chain in width on the surface. A little work has been done on this reef, but without satisfactory results. Most of the reefs in the greenstones run on a general bearing slightly west of north and east of south, and can often be followed for a considerable distance, *e.g.*, the Tumbulgum line, which has been traced for over a mile; their dip is usually pretty steeply to the eastward. In two cases reefs with an east and west strike have been worked with fairly satisfactory results, viz., at the Star of the East G.M. and the old Mt. Yagahong mine, now the Archibald Q.C. 47.

Generally speaking, the reefs are very irregular and bunchy. This state of things, however, may improve with depth, as at present little or no work has been done below about 150 feet, except on the Star of the East Reef, which has been worked to a depth of 500 feet. A lot of copper is present in all the reefs at Gabanintha, especially at the Mountain View G.M. (Dyer's) and the Tumbulgum G.M., some very rich stone having been obtained from both these properties. So far, the ore has consisted principally of the carbonates malachite and azurite, but doubtless sulphide ore will be met with a little below water level, when the value of the ore will probably improve.

In two cases lodes have been worked simply for their copper contents, viz., at M.L. 1N, where several small lodes, running about north-west and south-east, have been worked to a depth of about 40ft., and at G.M.L. 340N, where a small irregular north and south lode was worked to a depth of 30 or 40ft. Both these properties were abandoned at the time of my visit, and I was unable to examine them in detail; very little work appears to have been done on them, and from what little I was able to see I am of opinion that they are not likely to develop into payable copper propositions, especially when their distance from the railway line and smelting works is taken into consideration.

A considerable quantity of chrysocolla (silicate of copper) is found associated with the ore on G.M.L. 340N; this occurs as blebs throughout the stone, some of them being of fair size. From its general appearance, this is locally thought to be turquoise, and was worked as such; the following analysis, however, made in the Departmental laboratory, of a picked sample [5338] obtained from the mine by myself, rather explodes this theory:—

Silica, SiO_2	39·90	per cent.
Copper oxide, CuO	43·36	„
Ferrous oxide, FeO	·65	„
Magnesia, MgO	Trace	
Alumina Al_2O_3	*Nil*	
Phosphorus pentoxide P_2O_5	*Nil*	
Water at 100° C. H_2O	9·36	„
Water at a red heat, H_2O	7·42	„
	100·69	„

Asbestos, of an inferior quality, is found in small quantity on M.L. 1N, about three miles east of the townsite, occurring in small north and south veins in the greenstone.

WATER.

This locality is fairly well watered, water being met with in most of the mines at from 60 to 80 feet, and being of good quality; the supply, however, is at present limited, and further sinking and driving will be necessary before an adequate supply for the batteries will be obtained.

TIMBER.

Timber is fairly plentiful in this locality, but consists only of mulga.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit:—

ARCHIBALD Q.C. 47.—This claim is on the reef formerly worked by the Mt. Yagahong Company.

The reef is a large irregular east and west one dipping to the north, very flat near the surface, but with a fairly steep inclination below 40 feet; it consists of white quartz considerably ironstained, and is very irregular in size, ranging from a few inches to as much as eight feet near the surface; it pinches out very small at water level and also at the west end; at the east end there is a large make of stone, but it is of very poor quality. The reef is very much broken and faulted, and twists about in all directions, maintaining, however, a general east and west bearing; it has been worked out for a length of 100 feet down to water level, principally by the original company; the present owners are now doing a little work at the 40 feet level, and also near the surface towards the eastern end of the reef.

The country is very soft and rotten down to the 80 feet level, at which depth a good supply of fresh water was struck.

No work has been done below water level.

MT. YAGAHONG G.M.L. 189N.

Year.	Tons of ore treated.	Ozs. of gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	342·00	660·00	1·93
1897	1,056·00	945·60	·89
1898	663·00	786·75	1·18
1899	...	...	...
1903*	15·00	33·85	2·36
Total	**2,076·00**	**2,426·20**	**1·16**

* Registered as R.C. 47N (Wetherson & Bevan).

MOUNTAIN VIEW G.M.L., 379N.—Two reefs run through this property, one in a north and south direction and the other in a north-west and south-east, meeting near the main working shaft and then running northerly apparently as one reef. The work done on the property consists of a main working shaft, sunk near the junction of the two reefs to a vertical depth of 150 feet, from which drives have been put in along the reef for about 100 feet at the 80 feet and 150 feet levels. A little stoping has been done from the 80 feet level, but none from the 150 feet. A second shaft has also been sunk a little farther south to a depth of 40 feet, and a good deal of driving and stoping done at this level; these workings are, however, now abandoned.

The reefs consist of a mixture of quartz and highly foliated greenstone ranging in thickness from two to four feet, and are very irregular and broken. The quartz occurs for the most part in bunches, some of which are of considerable extent, while others only extend a few feet; these bunches are generally richer in their gold contents than the lode matter (foliated greenstone). Both the quartz and the lode matter carry a high percentage of blue and green carbonates of copper, the lode matter being in places particularly rich, some small pockets of ore being obtained averaging over 30 per cent. of copper.

The country consists of fine grained greenstone, and is commencing to get hard and settled in the bottom workings. Water level is 80 feet, the supply being fresh but limited in quantity.

MOUNTAIN VIEW G.M.L., 379N.

Year.	Tons of ore treated.	Ozs. of gold therefrom.	Average oz. per ton.
1901	43·00	33·20	·77
1902	54·00	52·20	·96
1903	366·00	337·95	·92
Total ...	**463·00**	**423·35**	**·91**

Golden Hope G.M.L. 461n, late Band of Hope.—A fair-sized quartz reef runs through this property on a bearing nearly north-west and south-east. Near the southern boundary of the lease it is faulted and turned due east for about 100 feet, when it dies out completely. This eastern arm, which is very broken and irregular and dips at a flat angle to the north, has been worked out to a depth of about 45 feet, at which point it gets very poor; some very rich stone was taken out of these workings, especially from close to the surface. The quartz in this part of the reef is very much broken and ironstained, but is apparently perfectly free from copper. The main north-west extension of the reef runs on a very perfectly straight course right through the lease, but is of low grade, and not much work has been done on it, though one or two small patches of rich stone have been taken out. It dips fairly steeply to the eastward, and averages about four feet in width, though it is considerably more in places. A small very much ironstained quartz leader runs along the hanging wall of the main reef; this is generally very rich, but is too small to be of much use, though a small parcel of very rich stone was taken out of it near the north end of the lease.

Most of the work done on this property was done by a former company. The present owners are doing a little work on the south end of the reef, at the 40 feet level, on some stone left by the original company, and are also engaged in prospecting along the surface farther to the north.

Golden Hope G.M.L. 461n. (late Band of Hope G.M.L. 370n).

Year.	Tons of ore treated.	Oz. of gold therefrom.	Average oz. per ton.
1901	101·00	161·95	1·60
1902	23·00	23·00	1·00
1903	86·00	115·00	1·33
Total ...	**210·00**	**299·95**	**1·42**

Canterbury G.M.L. 443n (late Murchison Queen).—A large lode runs through this property in a north-west and south-easterly direction, having a steep dip to the south-west. It consists of a belt of highly-foliated greenstone, through which run small veins and strings of quartz; it has no defined limits, but has been proved to carry gold in varying amounts for a width of 28 feet. The gold occurs in it in small irregular chutes, usually where the quartz is most abundant; some very rich specimens were obtained at the 45 feet level. The main shaft has been sunk to a depth of 80 feet; at 20 feet a short drive has been put in northerly along the lode, but no stoping done; at 45 feet a second drive has been put in 60 feet in the same direction, and the lode stoped out for a width of 20 feet for 12 to 15 feet up; no work has been done below this. The country gets very hard at about 60 feet, consisting of a ne-grained, slightly-foliated greenstone. A plentiful supply of d fresh water was struck at 70 feet.

CANTERBURY G.M.L. 443N (late Unity G.M.L. 122N).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1897	58·00	28·00	·48
1898	49·00	46·24	·94
1899	...	...	...
1900	58·00	18·00	·31
1903	23·00	11·60	·50
Total ...	**188·00**	**103·84**	**·55**

TUMBULGUM G.M.Ls. 32N, 46N.—A long line of reef runs in a general north and south direction through about the centre of these leases, and a lot of work has been done upon it down to a depth of 130 feet, mostly on the two northern leases. At present a little work is being carried on on the central block, principally at the 70 feet level. The reef right through the three leases is bunchy, and varies in thickness from three to eight feet; where being worked at present it is from three to four feet, being larger at the northern end; it runs nearly vertically, and consists of a belt of soft, highly-foliated greenstone with veins and bunches of quartz. These bunches, which are found on both the hanging and footwall of the reef, vary in thickness from a few inches to six or eight feet, and seldom extend for any great length, either longitudinally or vertically; they are invariably considerably richer than the lode stuff (foliated greenstone), which, as a rule, is rather low grade. Both the quartz and the lode stuff, right through the entire length of the reef, carry considerable quantities of carbonates of copper, and, in one or two instances, small pockets of very rich ore were obtained. In all cases the copper is present in sufficient quantity to pay for concentrating.

The country, as far as opened up, consists of soft, decomposed greenstone.

A good supply of fresh water was struck at 60 feet.

NANNINE GOLDFIELDS LTD. (TUMBULGUM) G.M.Ls. 32N, 46N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1897	606·50	255·06	·42
1898	90·00	96·20	1·69
1899	37·00	53·80	1·45
1900	845·00	331·00	·39
1901	2,013·00	839·45	·41
1902	...	...	...
1903	697·00	565·60	·81
Total... ...	**4,288·50**	**2,141·11**	**·50**

MT. BUNGAR G.M.L. 449N.—This property is situated abou four miles west of Gabanintha township; the workings are on small quartz reef, which runs slightly north of east and south o west, and is practically vertical; a shaft has been sunk on it to depth of 88 feet, and a drive put in westerly at this level for abou 50 feet, and a little stoping done; a short drive has also been pu in westerly at the 30 feet level. The reef, as exposed in th workings, is from two to three feet wide, and consists of whit quartz, somewhat copper-stained in places; the walls are clean an well defined, and consist of fairly hard schistose greenstone; a fe feet to the east of the shaft the reef cuts out completely, and n efforts have so far been made to pick it up again in this direction it should, however, from its appearance, live for a considerabl distance, both westerly and vertically.

The stone at present being taken out is expected to averag about 30dwts.

Good water was struck at 88 feet.

A second large quartz reef outcrops two to three chains nort of the shaft, and runs about north-east and south-west. So far n work has been done upon it.

MT. BUNGAR G.M.L. 449N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	...	...	...
1903	121·00	80·30	·66
Total ...	**121·00**	**80·30**	**·66**

STAR OF THE EAST G.M.Ls. 174N, 459N.—At the time of m visit the main workings on this property were shut down, and was unable to examine them owing to their being full of wate The main shaft has been sunk to a depth of 500 feet, and levels pu in at 150, 250, 350, and 500 feet; these have been continued ea from the main shaft for a distance of 300 feet, very little wor having been done to the west. A block 300 feet in length has bee stoped out from the 150 feet level to the surface. The reef in th lower levels is from four to six feet in thickness, while nearer th surface it is more irregular, varying from three to as much as 1 feet. The chute of gold worked extended from the main sha easterly for a distance of about 300 feet; it cut out suddenly about 160 feet in depth, and could not be picked up again; the sto below this point carried a small amount of gold, but was too lo grade to pay. At the present time (November, 1903) prospecti is being carried on near the surface in the hopes of striking anoth chute.

[illegible] (dry) known as Lake Annean.

Water was met with in large quantities below 150 feet; it was somewhat salt, but suitable for battery and cyanide purposes.

STAR OF THE EAST G.M.Ls. 174N, 459N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	9,888·00	11,575·00	1·17
1897	1,384·00	1,212·70	·87
1898	8,492·00	9,012·65	1·06
1899	2,220·00	1,721·10	·77
1900	3,434·00	2,173·84	·63
1901	1,013·00	1,803·36	1·78
1902	498·00	230·65	·46
1903	90·00	30·85	·34
Total	**27,019·00**	**27,760·15**	**1·02**

The following table shows the total gold returns from the leases at Gabanintha, other than those already mentioned, up to the end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
Bella	316N	20·00	20·00	1·00
Copper King	340N	14·50	1·85	·13
Freetrade	409N (268N)	25·00	27·50	1·10
Gabanintha	237 (48N)	304·00	207·50	·68
Kapunda Gabanintha	255N	11·00	11·75	1·07
Lady Maud	178N	60·00	130·00	2·16
Martindale	31N	177·00	157·77	·89
Myrmidon	268N	17·00	17·00	1·00
Sovereign	431N	137·00	90·85	·66
St. Albans	50N	301·00	431·40	1·43
St. Albans United	277N	55·50	62·35	1·12
Sundry claims	...	191·00	179·83	·94
Sundry parcels treated at Gore's (Canterbury) Battery	...	38·25	27·45	·71

Nannine.

The mining centre of Nannine is situated 50 miles north-east of Cue, and is the terminus of the railway line. The workings and townsite are situated on the northern shore of Lake Annean, on the southern end of a range of greenstone and quartzite hills, which rise to a height of about 100 feet above the level of the lake, and run slightly west of north; the country to the east and west of this range of hills consists of level plains covered for the most part with a considerable thickness of recent deposits. To the south is the shallow salt marsh (dry) known as Lake Annean.

A good deal has been written about the geology of Nannine,* and the following is taken from Mr. H. P. Woodward's† report on the Murchison goldfield:—

> Lake Annean is only shown on the map as a small round clay pan, but in truth it extends for about seven miles south, consisting of a succession of sandy ridges and marshes, which are impassable after rain. The main line of reef runs north from the lake up the spur of a rough ironstone ridge. It stands up in huge blows in places, and would, to anyone used to goldmining in other parts of the world, present a very unpromising appearance. But in spite of the fact that gold rarely occurs near these great blows, patches were found along this reef of great richness, and from holes a few feet in depth small fortunes were taken.
>
> On sinking these rich patches were lost, as the chutes dip to the north at such a slight angle, when it was thought that the reef would prove to be barren in depth, but fortunately the sinking was continued to water level, when the next rich chute from the south was struck, and in driving at this level to the north-west the first chutes worked were again found. These rich chutes in the main line dip north at an angle of about 30°, following the intersection, for the most part, of the ferruginous jaspery beds; besides these chutes of rich stone, the heavy bunches of rich stone and the breaks in the reef all follow the same dip, as well as the striations on the walls.
>
> The rocks are mostly schistose, with hard bands of ferruginous jaspery quartzite; these strike north and south, dipping at a high angle to the eastward, whilst the reefs strike a little east of north, and dip a little to the west where they do not go down vertically.

The range of hills, at the southern extremity of which Nannine is situated, consists of a series of roughly parallel greenstone ridges traversed by parallel bands of hæmatite-bearing quartzites, and trending in a general north-westerly direction. These ridges are from half to three-quarters of a mile in width, and gradually give place on the eastern side to level plains extending easterly, southerly, and northerly for many miles, and covered with a considerable thickness of recent deposits; on the western side, close to the foot of the ridges, the greenstones are replaced by massive granite, which appears to be intrusive, and which runs about north-west. After extending westerly for about a mile as fairly level country, the granite in turn disappears beneath the recent deposits of the plains, which then extend westward indefinitely.

THE GREENSTONES.

The greenstones are for the most part massive, showing only slight foliation over small areas, and consist of diorites, amphibolites, pyroxenites, and altered forms of the latter. A specimen [5350] of the latter variety, taken from G.M.L. 17N, is a fine-grained, slightly-foliated dark green rock, a section of which (470) seen under the microscope shows it to consist essentially of hornblende, augite, and felspar.

> The hornblende forms the greater part of the section, and is in irregular grains and masses; it is mostly a pale green variety, and is considerably chloritised in parts.

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* *Vide* page 12.

† The Murchison Goldfield by H. P. Woodward, page 17. Perth: By Authority, 1893.

Augite is abundant in colourless to pale brown crystals and grains, and is usually surrounded by the hornblende.

Felspar is fairly common throughout the section, and is in small grains and imperfectly-formed crystals; it is probably principally oligoclase, but is very clouded from the presence of decomposition products.

The hornblende appears to be an alteration product of the augite, which apparently originally formed the main constituent of the rock.

The greenstones are crossed by numerous diorite (?) dykes; these are not distinguishable from the surrounding rocks on the surface, and are only recognisable when met with in the workings below ground, where they are often found cutting across the reefs without, however, displacing them in any way.

THE QUARTZITES.

The hæmatite-bearing quartzites which traverse the greenstones are of the usual type, and run in parallel belts from a few feet to as much as two chains in width, having a general trend ranging from north-north-west to north-west, and have, in one or two instances at the south end of the field, been worked for their gold contents, but apparently without satisfactory results, as they have now been abandoned for some time past. They are slightly more siliceous here than is usually the case, and are very little faulted, running in very regular lines for considerable distances. The following is a partial analysis, made in the departmental laboratory, of a specimen [**5352**] taken from a spot 30 chains south of G.M.L. 249, Queen of the Lake:—

Metallic iron	31·28	per cent.
Silica...	47·48	„
Phosphorus	·312	„
Sulphur	·030	„
Hygroscopic water...	·28	„
Combined water	3·89	„

THE GRANITES.

The granite is a coarse-grained hornblende variety, and is considerably weathered; its general trend is between north and north-west; how far it extends in this direction is not known, but it runs southerly for from eight to 10 miles. A section (469) of a specimen [**5349**] taken from G.M.L. 115 shows it to be a coarse-grained holocrystalline rock, consisting essentially of:—

(*a.*) Quartz: occurring plentifully in irregular lumps and and grains.

(*b.*) Felspar: principally orthoclase, together with a little plagioclase and some microcline; it is in large plates and imperfectly formed crystals, and is for the most part considerably decomposed and altered with the formation of small flakes of colourless mica.

(*c*.) Hornblende: abundant, in large flakes and lumps and of a brownish green variety considerably decomposed. A few crystals of pale brown augite also occur associated with the hornblende, and in addition to these a few minute crystals of apatite are present.

Another specimen [5351], taken from the dump on G.M.L. 13 (Champion), though differing slightly in its macroscopic properties, when seen under the microscope is practically identical with the preceding, except that the felspars exhibit greater clouding and alteration, and augite is more plentiful; a few scattered grains of magnetite also occur throughout the section, and in addition there are present numerous small crystals of sphene.

One or two dykes of felsite also cut through the greenstones, one large one, occurring about a mile to the north-east of the town, being traceable across country for fully a mile.

THE REEFS AND LODES.

Quartz reefs are found both in the greenstones and in the granite, and are usually large and well defined. Most of those in the granite have a trend slightly east of north, and dip to the westward; while those in the greenstones usually trend a little west of north, and also dip to the westward—generally at a fairly flat angle. In some cases the same reef is found running through both granite and greenstone. One of these is the "Nannine," one of the largest in the district, and which outcrops for a distance of over a mile. For the greater part of its length this reef is in the greenstones, but near its southern end it runs into the granite, still maintaining the same bearing, and apparently the same dip. Another is the reef running through the Burgundy and Old New Year leases, which in the former is in greenstone, and in the latter in granite. Most of the reefs in the granite appear to have been of low grade, and are now all abandoned.

Two classes of quartz reefs are found in the greenstones, the first being associated with the hæmatite-bearing quartzites, and the second occurring at some distance from them, and usually close to the junction of the greenstones and the granite. The former vary greatly in size, but are always very irregular, and the gold in them is patchy, short rich chutes being obtained at the points where they intersect or come in actual contact with the quartzites, while the bulk of the reef is blank or, at best, low grade. Several reefs of this nature have been worked at the southern end of the field, but are now abandoned.

The reefs occurring near the junction of the greenstones and granite are usually large and well defined, and outcrop for considerable distances; their gold contents, also, are more uniform, though occasionally small rich chutes are found in them, this being especially the case in the "Nannine" reef, which, at its northern end, cuts across several quartzite bars, rich chutes being obtained at the points of intersection.

A considerable quantity of alluvial gold has been obtained from this district, especially from "Bailey's Island," about a mile and a-half to the south of the townsite, and also on the eastern fall of the ridge to the east of the town; in all cases the gold has been found in close proximity to the quartzites and has probably been derived from small quartz reefs and leaders associated with these. Most of the rich patches appear to have been worked out, and very little is being done in this line at the present time.

WATER.

Water is fairly plentiful, and at a little distance from the edge of the lake it is fresh, and is reached at a depth of from 60 to 70 feet. Near the shore of the lake its level is only a few feet below the surface; the supply is unlimited, but it is of course exceedingly salt.

TIMBER.

Timber consists only of mulga, and is becoming very scarce.

At the time of my visit (November, 1903), mining operations were very quiet at Nannine, there being only three or four mines working, and these only in a small way; the Champion mine was practically shut down, but it was reported that it was shortly to start sinking and development work again; this should prove a good thing for the district, and this is the biggest and best equipped mine in the place, and though the reef is very low-grade just at present, there is no reason why it should not improve again at a little greater depth.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit, as far as I was able to examine them:—

CHAMPION GOLD MINES, G.M.Ls. 11N, 17N, 13N, ETC.—I was unable to examine the deeper workings on these properties owing to their being full of water at the time of my visit; the only examination that could be made was at the 70-feet level, where there was very little to see owing to the fact that the greater part of the stone had been stoped out. The reef, which is in the greenstones near their junction with the granite, and which has been followed for a distance of nearly a mile, runs on a bearing about 30deg. west of north, and dips at a flat angle to the westward; it varies a good deal in size in the upper workings, being as much as 12 feet in width in some parts, while in others it is not more than two; in the lower levels it is said to be much more regular. It has been worked to a depth of 500 feet on the underlay, and a large amount of work done on it; at the south end, on the Caledonia lease, it is more broken and much smaller. A little to the north of the main underlay shaft a second reef comes in on a bearing almost due north and south; this reef, which is about two feet in width, has been followed on the surface for a distance of about 15 chains, but not much work has been done on it. The gold in the main reef is somewhat patchy and is said to be getting very poor at the lower levels. The stone above water is a clean, white, laminated quartz, very free from copper or other mineral.

Champion Reef (Nannine, W.A.) G.M. Co., Ltd.
G.M.Ls. 10N, 11N, 17N (37N, 43N).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1897	9,803·00	4,687·23	·50
1898	1,511·00	1,056·20	·69
1899	733·00	390·70	·53
1900	4,670·00	2,005·30	·43
1901	1,383·00	380·40	·27
1902	4,972·00	3,043·05	·61
1903	876·00	*3,162·75	...
Total	**23,448·00**	**14,725·63**	**·62**

* Includes 2,262·15ozs. by cyanide.

Nannine Gold Mines G.M.L., 16N, 25N, 166N.—A large white quartz reef runs through these properties, and the adjoining ones on a bearing slightly east of north and west of south, and can be followed in an almost perfectly straight line on the surface for a distance of over a mile. For the greater part of this distance it is in greenstone, but near its southern end it is in granite running close to the junction of the latter with the greenstones. It varies a great deal in size in some places, being as much as 20 feet in width, while in others it pinches down to two or three; towards its northern extremity it is small and very much broken and faulted. It has been worked at intervals along its entire length, but at the southern end is very low grade. The majority of the work done on it is on the Nannine and Royalist leases, where it has been worked to a depth of about 200 feet.

These leases are crossed by a series of quartzite bars which run in a north-west and south-easterly direction and dip at a steep angle to the eastward; these bars are cut by the reef, and at the points of intersection rich chutes of gold are usually found, while at a little distance from the bars the stone is, for the most part, of fairly low grade, though small rich chutes are found in it in irregular intervals. I was unable to go through the lower workings on these properties owing to their being flooded, and so was unable to examine the reef or the country below the 120ft. level. At this depth a drive has been put in along the reef for a total distance of about 400 feet, and a little stoping done here and there. The reef, as shown here, is very bunchy, ranging, as before stated, from two to nearly twenty feet.

The country at this depth is very soft and broken.

The reef appears to be much more regular in size to the south, but I was unable to examine it here owing to all the workings being abandoned; it is crossed by several diorite (?) dykes, one near the south boundary of the Nannine lease being about 120 feet in width and running almost due east and west for some distance, which cut right through it without displacing it at all.

The water level is about 90 feet, and the supply is good.

Nannine Leases 16N, 25N, 166N.

Year.	Tons of Ore treated.	Ounces of Gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	2,420·00	5,193·00	2·14
1897	232·50	230·08	·98
1898	433·00	278·96	·64
1899	1,444·00	4,466·58	3·09
1900	915·03	*2,866·26	3·13
1901	32·00	1,364·26	42·63
1902	809·00	881·82	1·09
1903	1,475·60	1,833·31	1·23
Total ...	7,761·13	17,114·22	2·20

* Includes 22·50 ozs. dollied and specimens.

Queen of the Lake G.M.L., 249N.—The main workings on this property are on a large irregular lode formation trending about north-east and south-west, and dipping at a fairly flat angle to the north-west; it appears to be simply a highly altered belt of greenstone, and has no defined limits. A good deal of work has been done on it to a depth of 200 feet, but at the time of my visit these workings were abandoned, and a little work was being done on the north end of a quartzite bar running through the lease near its eastern boundary. Several of these bars run through the property, and, as usual, rich chutes of gold were obtained at the intersection of the lode with them, and also at the intersection with them of a second quartz reef farther to the west.

Mt. Yagahong G.M. and Explorations Co., Ltd., G.M.L. 249N. (late Queen of the Lake G.M.L.)

Year.	Tons of Ore treated.	Ounces of Gold therefrom.	Average ozs. per ton.
Previous to 1897 ...	7,374·00	5,943·00	·80
1897	1,185·00	551·40	·46
1898	...	...	..
1899	1,060·00	437·90	·41
1900	90·00	85·00	·94
1901	1,258·00	794·80	·63
1902	189·50	166·65	·88
1903	56·00	48·10	·86
Total ...	11,212·50	8,026·85	·71

The following table shows the total gold returns from the leases at Nannine, other than those already mentioned, up to the end of 1903:—

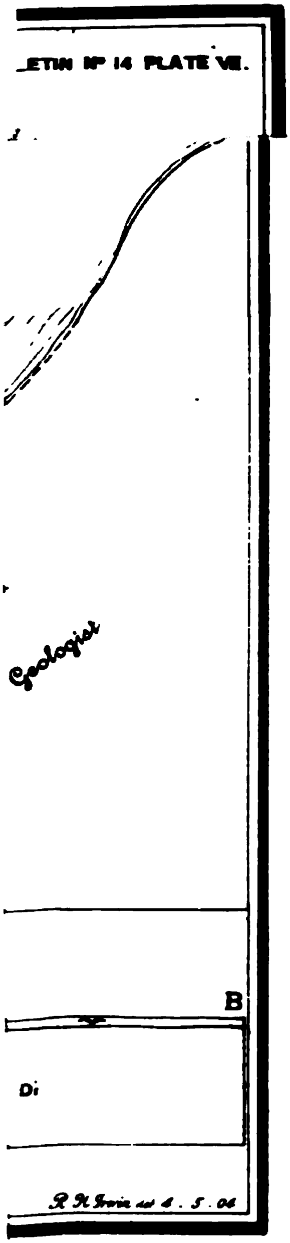
Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Anglo Westralian and General Exploration, Ltd.	54N, 55N	107·00	32·85	·30
Barrett's Peak	320	35·00	7·45	·2
Caledonian	273N (168N)	887·00	1,438·65	1·6
Caledonian Extended	8N	413·50	2,113·77	5·1
Commonwealth	342N (219N)	41·00	67·70	1·6
Daisy	457N	57·00	200·00	3·6
Dunaustral	429N (267N)	...	† 40oz.	...
Alberfoyle G.M., Ltd.	242N, 261N (267N)	93·00	*290·67	3·1
Esmeralda	102N	16·00	25·20	1·5
Golden Gate	463N	...	‡73·85oz.	...
Granite King	421N (330N)	108·00	143·45	1·3
Iron King and Kaiser Proprietary	73N, 113N	50·00	51·50	1·0
Lake Shore	240N	49·00	48·75	·9
Mt. Yagahong Exploration Co., Ltd.	7N, 15N, etc.	13,944·00	11,541·91	·8
New Caledonian	264N	136·00	223·55	1·6
New Year G.M., Ltd.	18N	717·50	590·40	·8
Old New Year	438	111·00	80·35	·7
Pearl	308N	80·00	34·20	·4
Referendum	343N	41·00	50·00	1·2
Three Star	484	12·00	3·95	·3
Wanganui G.M. Co., Ltd.	415N	1,922·00	675·10	·3
(Graham and party)	P.A. 124	29·00	65·85	2·2
(Hughes and party)	P.A. 132	20·00	18·90	·9
Sundry Claims	...	654·50	1,083·05	1·67
Sundry parcels treated at Queen of the Lake Battery	...	10·00	26·00	2·6
Nannine District generally ...	...	...	†3,087·70	...
Sundry parcels treated at Nannine Cyanide Works	...	...	202·76oz.	...

* Includes 62·85ozs. dollied and specimens.
† Alluvial.
‡ Dollied and specimens.

The Country between Nannine and Abbotts.

From Nannine the country passed over consists of extensive flats, covered with recent deposits which apparently overlie greenstones, and sparsely timbered with mulga. This class of country continues unbrokenly to Meekatharra, at which point there are a series of low greenstone and quartzite ridges, extending to a point about two miles north of the townsite, where granite again makes its appearance as a level sandy tableland, with bare outcrops of rock here and there. Near Garden Gully this once more gives place to the greenstones, which extend for several miles as low ridges, gradually dying out and giving place to level plains covered with recent beds of red sandy soil; these continue to within a few

ETIN Nº 14 PLATE VII.



hotolithographer. Perth, W. A.

miles of Abbotts. Here the country becomes hilly, the hills being greenstone for the most part covered with a considerable thickness of ironstone conglomerate (laterite).

Meekatharra.

The mining centre of Meekatharra is situated about 24 miles slightly east of north of Nannine. As shown on the Mines Department route map, it is some 10 miles out of position (to the west), being shown as at Trig. Station K.6, on Meekatharra hill, whereas it is at Luke's Trig., some 10 miles due east of this point, and on the main surveyed road from Nannine to Peak Hill.

The country in the immediate vicinity of Meekatharra townsite consists of low, rough, greenstone ridges, extending southerly for about two miles, when they give place to extensive plains covered with recent deposits; westerly for three miles; and northerly for two, when they are replaced by a large belt of granite trending about north-east; easterly they extend indefinitely.

These greenstones are very much decomposed and weathered, so much so that it was impossible to obtain a specimen for determination, none of the mine workings being down below the zone of decomposition. Immediately to the east of the townsite is a wide belt of banded quartzite trending slightly east of north and forming a low ridge, on the highest point of which Luke's Trig. is situated. At this spot the belt is about three chains in width, but thins out considerably as it runs south. It only continues a short distance north of the trig., but can be followed southerly for a couple of miles. At their northern end the quartzites are practically free from iron, and closely resemble those occurring at Lennonville,[*] whilst at their southern end, where there are several parallel bands and where they are more irregular, they are of the usual hæmatite-bearing variety, but appear to be much more siliceous than is generally the case.

The granite which occurs to the north and west of the townsite is a coarse-grained massive variety, extending northerly for five or six miles, and being for the most part covered with a considerable thickness of loose, sandy soil, with the rock occasionally outcropping as low, bare ridges. Numerous dykes run out from this main body into the greenstones, which are considerably foliated in close proximity to them.

A section (472) of a specimen [5354] of this granite, taken from a spot about a mile north of the Havelock G.M.L., seen under the microscope, shows it to be a very similar rock to that occurring at Cuet[†], and consisting of—

(*a.*) Quartz: fairly abundant, in fair-sized grains and lumps, for the most part without crystalline boundaries.

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[*] Geological Survey, Bulletin 8, page 15. Perth: By Authority, 1903.

[†] *Vide* page 14.

(*b.*) Felspar: plentiful in large plates and imperfectly formed crystals, and consisting principally of orthoclase, with some plagioclase and a little microcline. It is a good deal clouded from the presence of decomposition products.

(*c.*) Hornblende: of a greenish brown variety, and occurring in the form of irregular flakes and lumps.

(*d.*) Biotite: occurring in parallel intergrowth with the hornblende.

One or two small crystals of colourless augite are also present, as well as a little sphene, in fairly well-formed crystals, and a few scattered grains of magnetite.

A second large similar belt of granite occurs about 10 miles to the east of the townsite, trending about north and south. A few small deposits of ironstone gravel (laterite) occur on the greenstone ridges; these are usually of very limited extent, but are often of a very high grade; in one instance, viz., just north of the Democrat G.M.L. 425, a small deposit of this nature is highly magnetic.

The auriferous quartz reefs of the district trend generally a little to the east of north, and are for the most part large and appear to be fairly regular in their course; so far, however, no work has been done in the district below water level, and not a great deal above either, but as far as opened up the majority of the reefs are very promising, and though some of them are rather irregular in the soft country in the upper levels they should improve as they get into the harder and more settled country below water.

As a rule, too, the gold is fairly uniform right through the stone, and is not found occurring in short chutes as in many other centres on the Murchison Goldfield.

Mining operations were very brisk at the time of my visit, and altogether I am of opinion that this centre has a very good future before it.

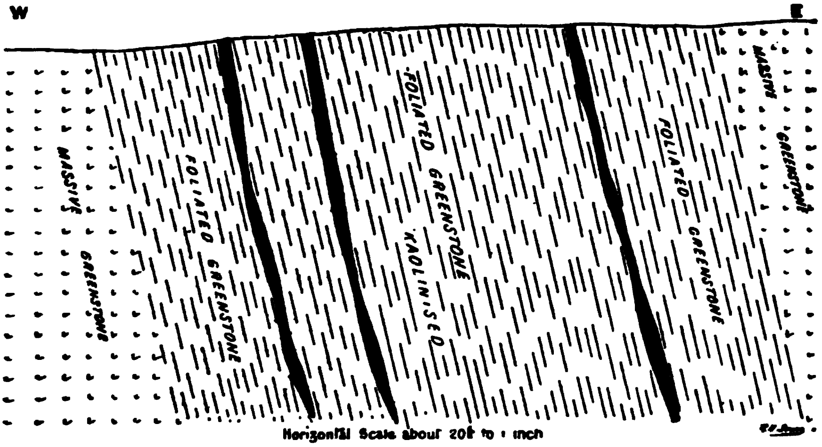
Fresh water is met with in the mines and wells at a depth of from 130 to 150 feet; the supply, however, appears to be somewhat limited, this being especially the case in the town wells, which frequently go nearly dry in the summer months; this might be remedied by further sinking and crosscutting. A new well for town supply purposes has just been put down four or five miles to the south-west of the townsite, and at present is giving a good supply of fresh water. Timber for mining purposes and for fuel is still fairly plentiful, but consists only of mulga.

The Mines.

The following is a brief description of the principal mines working in the district at the time of my visit (December, 1903):—

Havelock G.M.L. 236n.—Three or four parallel lines of reef un through this and the adjoining properties on a bearing slightly east of north and west of south, having a uniform dip of about 75° to the east. On the most eastern of these several shafts have been sunk to a depth of 100 feet, and about 400 feet of driving put in along the reef at this level, and a good deal of stone taken out between this and the surface. Considerable work has also been done on a couple of reefs farther west. The eastern reef, which is the richest of the series, is from four to six feet in width, and consists for the most part of white friable quartz, considerably broken and associated with large quantities of kaolin; the other reefs, which are some 20 feet farther west, are similar in appearance but smaller, being from two to three feet in width. The country between them consists of very soft kaolinised greenstone foliated parallel to the lines of reef, and carries a little gold for its entire width. (Fig. 5.)

Fig. 5.



CROSS SECTION SHEWING THE MODE OF OCCURRENCE OF HAVELOCK REEFS NEAR MAIN SHAFT MEEKATHARRA

The reefs are crossed by several east and west faults, which dip to the south and throw the reefs to the east for a distance of from six to twelve feet; short rich chutes are generally found where these lines of fault cross the reefs.

Havelock G.M.L. 236n.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1899	54·00	58·00	1·08
1900	136·00	188·70	1·38
1901	580·75	355·80	·61
1902	193·00	233·30	1·20
1903	711·50	504·65	·70
Total ...	**1,675·25**	**1,340·45**	**·80**

Havelock South G.M.L. 279N.—This lease adjoins the Havelock on the south. The workings are on one of the western lines of reef worked on the latter, and are down to a depth of 125 feet, at which level a good deal of driving and stoping has been done on the reef, which is more bunchy in this lease, varying from two and three feet up to as much as 20 in one place; its gold contents, too, are not as regular as in the Havelock. Several lines of fault cross the reef in an east and west direction, and dip fairly steeply to the south; they usually have a beneficial effect on the reef, which is generally richer in proximity to them; small quartz veins, up to three and four inches in width, are often found following these fault lines; they are usually very rich, and in one or two cases were large enough to pay to follow.

At the 100 feet level a crosscut has been put in easterly for a distance of 80 feet, prospecting for other parallel reefs, but without success. The country cut through consists of very soft kaolinised greenstone foliated parallel to the line of reef, and carries gold to the value of two or three dwts. per ton for the whole distance.

HAVELOCK SOUTH G.M.L. 279N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom	Average oz. per ton.
1901	188·00	191·05	1·01
1902	394·00	254·45	·65
1903	563·25	203·65	·36
Total	**1,145·25**	**649·15**	**·56**

Havelock North G.M.L. 257N (late Lone Hand 422N).—This block adjoins the Havelock on the north, and the workings are on the same line of reef; a good deal of work appears to have been done, but the old workings are all abandoned; a vertical shaft is now being sunk slightly to the east of the main line of reef and had just cut it at 100 feet. The only workings I was able to examine consisted of an underlay shaft down about 100 feet, from which about 200 feet of driving have been done, and also a little irregular stoping. Two lines of reef have been worked; the more eastern, on which most of the work has been done and which is apparently the same reef as is being worked in the Havelock, is from four to six feet in width, and very patchy; the stone is mixed with a large amount of kaolin, and is white and very friable; the gold occurs principally in short irregular chutes, though the reef carries a little gold throughout; the second reef, which is a little smaller, is about twenty feet to the west; not much work has been done upon it, as it was rather low grade where struck; it is similar in appearance to the eastern reef. The country between the two, as in the Havelock, carries a little gold right through. Both reefs dip at a fairly flat angle to the eastward. Several other shafts have been sunk on these reefs, but I was unable to examine any of them owing to their having been abandoned for some time past.

Near the north end of the lease the reefs cut out altogether, and the whole nature of the country changes; this is apparently brought about by a large fault which crosses the country here in an east and west direction; up to this point the country consists of a very soft white kaolinised greenstone foliated in a north and south direction—parallel to which the reefs run; beyond it the lines of foliation run east and west, and the country is much harder and not so altered.

So far, no signs of water have been met with in any of these three mines; this is owing to the fact of their being on much higher ground than any of the other mines in the district.

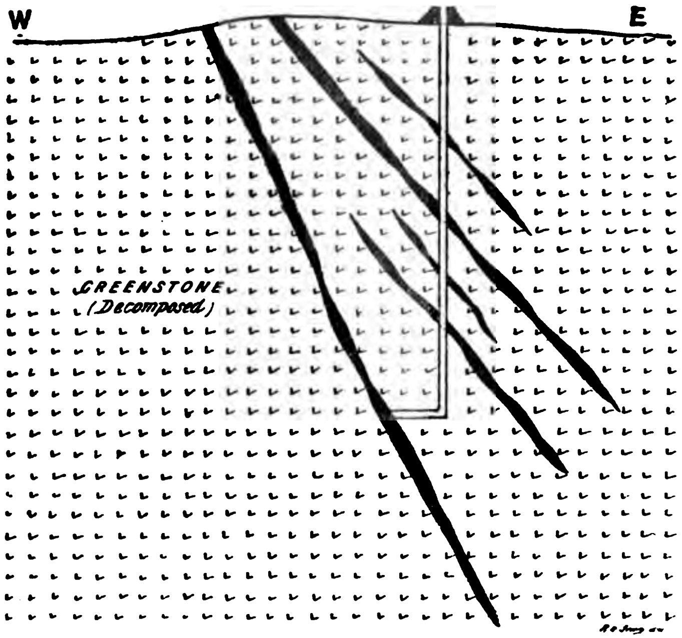
HAVELOCK NORTH (late LONE HAND G.M.L. 422N.)

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	203·00	73·95	·36
1902	300·50	149·45	·49
1903	104·00	25·10	·24
Total ...	**607·50**	**248·50**	**·40**

PIONEER G.M.L. 372N.—Several large quartz reefs run through this property on a bearing slightly east of north and west of south; on one of them a shaft has been sunk to a depth of 180 feet, and drives put in at the 100 and 180 feet levels, that at the 100 feet being 150 feet in total length, and that at the 180 feet about 30 feet longer; no stoping has so far been done from this latter level, but from the 100 feet a block 125 feet in length has been stoped out up to the surface. At the north end of the workings the reef, which dips steeply to the east, is about twelve feet in width, but in the south end it gradually cuts out altogether in the upper levels, but in the lower it is still going strong, with every likelihood of continuing for some distance; it is not uniform in size, ranging from two or three feet to as much as twelve. The footwall is very clean and regular, but the hanging wall is not so good. The reef is not being worked for its full width in the lower level, only a few feet of stone on the footwall side being taken out. The chute of gold being worked is about 100 feet in length, and dips to the south at a fairly flat angle in the upper levels, but steeply below.

The original reef worked is about a chain to the east of the one at present worked, and runs parallel to it, dipping in the same direction, but at a considerably flatter angle; it is smaller than the main reef, more irregular and not so good. Several other small reefs were cut in sinking the main shaft; these vary in size from a few inches to a couple of feet (Fig. 6), but were very poor where struck, and no work has been done upon any of them. The country, as far as opened up, is still very soft, consisting of a very much decomposed greenstone. Water was met with at 180 feet, and is fresh.

Fig. 6.



CROSS SECTION SHEWING THE MODE OF OCCURRENCE OF REEFS AT PIONEER MAIN SHAFT
MEEKATHARRA

Pioneer G.M.L. 372n. (late Meekatharra 90n).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1898	61·00	47·35	·77
1899	...	...	...
1900	...	...	...
1901	283·00	251·70	·88
1902	888·75	996·05	1·12
1903	1,124·50	1,993·35	1·77
Total ...	2,357·25	3,288·45	1·39

St. George G.M.L. 323n.—The main line of reef on this lease runs through about the centre of it, on a bearing nearly north-east and south-west. On the surface it is a large white quartz reef, which outcrops for a distance of about 30 chains. Several shafts have been sunk on it, the deepest to a depth of 69 feet, at which level a drive has been put in along the reef for 140 feet and a little stoping done; the reef in this drive is about two feet in width, and dips to the east at a fairly flat angle; at present a crosscut is being put in at the 30 feet level to cut a large quartz reef about two chains to the west. This reef, which is the larger of the two, runs nearly parallel to the other at the north end, but a little south of the main shaft it turns and joins it, the two running south from this point as one reef. This reef also dips to the eastward at an angle of about 60 deg.; a little work has been done upon it at its junction with the eastern reef but it is at present too low grade to pay. A third reef, trending nearly east and west, runs into the main reef about three chains north of the working shaft; it is from 12 to 15 inches in thickness and dips deeply to the south. It is, however, too poor to be of any use.

St. George G.M.L. 323n.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	142·00	75·20	·53
1902	82·00	62·50	·76
1903	142·75	70·55	·49
Total	**366·75**	**208·25**	**·56**

Pioneer South G.M.L. 426n.—A large number of reefs run through this property in different directions, and a good deal of work has been done on them at different times. Near the south-western corner of the lease two small parallel reefs run on a north to north-westerly bearing; on the more northern of these a shaft has been put down to a depth of 150ft. and the reef stoped out for about 100ft. each way from the shaft from this level to within about 20ft. of the surface. This reef is from one to three feet in width and consists of clear glassy quartz; it dips at a fairly steep angle to the south-west. The gold in it was very patchy, some of the stone being very rich and some a few feet away scarcely carrying a trace.

The country is very soft white kaolinised greenstone. A little work has also been done on the more southerly of these two reefs, but they are at present both abandoned.

At the extreme north end of the lease a shaft has been sunk to a depth of 150 feet, and a little east and west crosscutting done with the intention of cutting the south continuation of the Pioneer reef. Only a few small leaders were cut in these workings, and the shaft appears to have been sunk right on a line of fault, which has thrown the reef some distance out of its original course. Several other shafts have also been sunk near the north end of the lease on a couple of large quartz reefs which outcrop there; these, however, proved to be very low grade, and they have since been abandoned.

The present workings are situated towards the south-eastern corner, where a shaft has been sunk to a depth of about 50 feet and a short drive put in at the 30 feet level on a small quartz leader running nearly north and south and dipping at an angle of about 45° to the east. This leader is from six to twelve inches in width and gives very good prospects; the quartz is white and glassy and very broken, and has associated with it in cavities considerable quantities of talc.

In sinking the shaft a large white sugary quartz reef was cut through. This reef runs north and south and dips very flat to the east; its exact width is not known, but it is at the least 20 feet; at the point where cut it was very poor, and no work was done on it; apparently it is the continuation of the large quartz reef worked in the Meekatharra South Block, the adjoining lease on the south.

The country is very soft and consists of white kaolinised greenstone.

PIONEER SOUTH G.M.L. 426N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1901	22·50	14·20	·63
1902	...	...	...
1903	47·00	49·18	1·04
Total ...	69·50	63·38	·91

MEEKATHARRA SOUTH BLOCK G.M.L. 93N.—The main workings on this property are situated on a large quartz reef running about north-east and south-west through the centre of the lease. The present workings consist of a large open cut worked to a depth of 75 feet and drives along the reef at this level. As shown in the open cut, the reef is about 40 feet in width and dips to the west at an angle of about 75 deg.; it consists principally of soft sugary quartz, with considerable quantity of talc in cavities, but in places becomes hard and glassy; it carries gold in small quantities for its full width, as well as containing numerous small, irregular pockets of rich stone. At the north end of the open cut, at the 75 feet level, the reef is lost and appears to have been cut off by an east and west fault dipping south at a very flat angle. It has been worked out for nearly its full width near the surface, but below about 30 feet only a strip along the footwall has been taken out and drives have been put in along and across the reef to test its values.

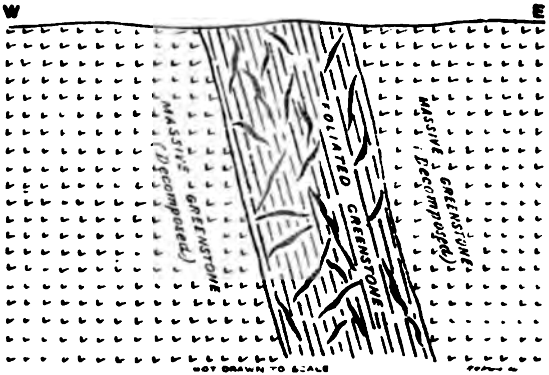
The original workings on the property are some four chains south of the present ones; here some very rich stone was found on the surface, and a shaft was sunk on the eastern side of the reef to a depth of 150 feet, and a crosscut was put in to cut it at this level; nothing was met with in this crosscut, and it appears as if it has been put in along, or close to, a line of fault, and not continued far enough to cut the reef, which appears to have been thrown to the west. Several other reefs outcrop at the southern end of the lease, but no work has been done upon any of them.

MEEKATHARRA SOUTH BLOCK G.M.L. 93N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
1898	53·00	160·00	3·02
1899	72·00	130·25	1·80
1900	110·00	150·90	1·37
1901	753·00	561·10	·74
1902	580·00	344·50	·59
1903	593·50	189·45	·32
Total ...	**2,161·50**	**1,536·20**	**·71**

HALCYON G.M.L. 313N.—The main ore body on this lease consists of a large lode running slightly west of north to a point near the northern boundary, when it turns slightly and runs a little to the east of north. This lode consists of a belt of decomposed rock, through which small quartz leaders (Fig. 7) run in all directions, varying in size from a mere thread to several inches; at a depth it will probably turn into a belt of highly foliated greenstone, but, as far as opened up, both it and th

FIG. 7


W
E
MASSIVE (Decomposed) GREENSTONE
FOLIATED GREENSTONE
MASSIVE (Decomposed) GREENSTONE
NOT DRAWN TO SCALE

CROSS SECTION OF HALCYON LODE. MEEKATHARRA country are so decomposed and altered that it is almost impossible to tell where one ends and the other begins, except by noticing when the leaders cease, as these are only found within the lode; both the lode stuff and the leaders carry gold, some of the latter being extremely rich, whilst others are perfectly barren. On this lease, the lode has been proved to exist for a width of 16 feet, and appears to run almost vertically. The work done on it consists of an open cut 50 feet in depth and about the same in length and a shaft sunk to a depth of 100 feet; not much work has been done from this. The whole of the lode, as exposed in the open cut, is said to average about 10dwts.

The owners are at present engaged in working a series of fair-sized quartz leaders, running westerly into the main lode and dipping at a flat angle to the south; several of these leaders were cut within a few feet of each other in sinking an air shaft a couple of chains to the east of the main lode, and ranged in size from six inches to a couple of feet; one of them has been followed, at the 75 feet level, easterly from the main lode for about 90 feet, and a little stoping has been done on it; it is rather irregular and bunchy, varying from six inches to as much as three feet in places; its gold contents also vary considerably, parts of it being phenomenally rich, while parts, again, are very poor; taking it all through, it is expected to average about an ounce.

HALCYON G.M.L. 313N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1900	23·00	* 56·45	2·41
1901	304·25	233·80	·76
1902	181·50	220·75	1·21
1903	462·25	190·70	·41
Total... ...	971·00	701·70	·72

* Includes 2·45ozs. of dollied and specimens.

DEMOCRAT G.M.L. 425N.—There are two sets of workings on this property. Those at the south end are on the northern continuation of the main lode worked on the Halcyon, which has here been worked down to a vertical depth of 150 feet. Down to the 120 feet level only the larger and richer of the quartz leaders were worked, and the workings are of a very irregular nature on account of this. Below 120 feet the lode has been taken out for its full width, but only for a short distance; it is here about 20 feet in width and dips steeply to the east, having the same characteristics as in the Halcyon.

The other workings are near the north-east corner of the lease, where a good deal of work appears to have been done on a similar class of ore-body running north and south.

Both these workings were abandoned at the time of my visit.

Democrat G.M.L. 425N (337N).

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	142·00	127·80	·90
1903	423·50	116·70	·27
Total ...	**565·50**	**244·50**	**·43**

Commodore G.M.Ls. 283N, 284N.—At the south end of this lease a number of shafts have been sunk for the purpose of working a small quartz reef running north-east and south-west, and dipping to the westward. A good deal of work appears to have been done on it, and on a series of leaders running into it in all directions. These working were abandoned at the time of my visit, and I was unable to examine them. The main shaft is down 150 feet vertically to water level, the water being fresh.

At the north end the workings are on a fair-sized north-east and south-west quartz reef, which is probably an extension of that worked to the south; it is here as much as four feet in width in places, but frequently pinches to only a few inches. The hanging wall is very clean and sharp, but the footwall is not so good; it dips at a fairly flat angle to the westward. Several shafts have been sunk on it, the deepest being 120 feet on the underlay; drives have been put in from this shaft for a distance of 100 feet at both the 80 and 120 feet levels, but very little stoping has been done. The reef, on the whole, is low grade, though there were one or two small rich bunches on it. One or two smaller leaders come in from the east, and a little work has been done on one of them. A large lode formation runs east and west near the main underlay shaft; this formation is full of small quartz leaders, some of which are very rich, but the lode, as a whole, is too poor to work; its width has not been proved, but it is about 20 feet. Very little work has been done on it.

Commodore Leases G.M.Ls. 283N, 284N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1900	118·00	382·00	3·23
1901	297·25	1,113·80	3·74
1902	227·25	493·45	2·17
1903	613·50	385·30	·62
Total ...	**1,256·00**	**2,374·55**	**1·89**

Ingliston G.M.L. 363N.—This lease adjoins the Commodore on the south; the workings are on the continuation of the Commodore's south reef, which is here about two feet in thickness.

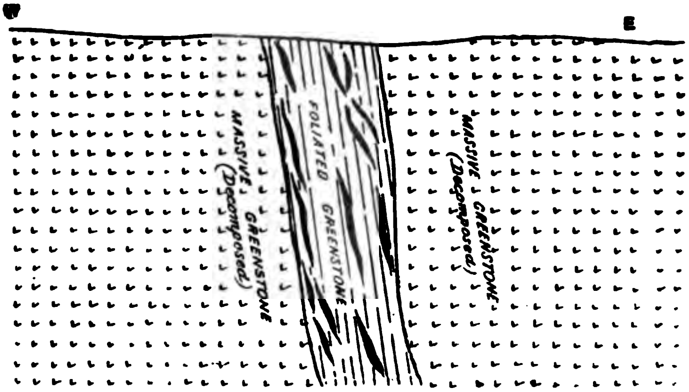
The main shaft is down 150 feet to water, and drives have been put in along the reef at 100 and 150 feet levels; about 150 feet of driving and a good deal of stoping have been done at the 100 feet level, and about 300ft. of driving, but practically no stoping at the 150ft.; the reef is bunchy, varying from 1 to 3 feet, but averaging, on the whole, about 2ft. The country is very soft and rotten all through the workings. The water supply is fresh.

INGLISTON G.M.L. 363N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1901	114·00	245·60	2·15
1902	182·50	211·85	1·16
1903	50·50	43·00	·85
Total	**347·00**	**500·45**	**1·44**

INGLISTON EXTENDED G.M.L. 398N.—The workings here are on a large lode running about north-east and south-west, and dipping at an angle of about 75° to the eastward. This lode consists of a soft belt of highly altered greenstone throughout which is disseminated a considerable quantity of quartz in irregular veins and masses. As far as opened up at present it is very ill-defined, there being no hard-and-fast boundary between it and the country from which, owing to their both being so decomposed and rotten, it is almost impossible to distinguish it; its lateral limits can at present only be defined by the decrease in its gold contents; its width, as far as defined by these means, varies from 8 to 20 feet. At a depth it will probably be found to consist of a belt of highly-foliated greenstone, rrying a considerable amount of quartz, and will be much more

FIG. 8.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MASSIVE GREENSTONE (Decomposed)
FOLIATED GREENSTONE
MASSIVE GREENSTONE (Decomposed)

CROSS SECTION OF INGLISTON EX LODE, MEEKATHARRA.
NOT DRAWN TO SCALE

regular and defined. Several shafts have been sunk on this line of lode, the deepest being 125ft. vertical, and a lot of driving and stoping done on it. The country (greenstone) is very soft and rotten as far as opened up. Water was struck at 125ft., and is fresh.

INGLISTON EXTENDED G.M.L. 398N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	307·00	367·10	1·19
1903	854·25	644·90	·75
Total	**1,161·25**	**1,012·00**	**·87**

INGLISTON CONSOLS G.M.L. 475N.—On this lease a shaft has been put down to a depth of 45ft., for the purpose of working a small quartz reef, running about north-east and south-west. Work is at present being carried on at the 35 feet level, where a couple of short drives have been put in, and a little stoping done. The main reef, which, as far as opened up, has a very irregular course, varies in width from a mere thread to two or three feet, and dips at a fairly flat angle to the east; its gold contents are very patchy, some of the makes of stone being very rich, while others are practically barren. A second small reef comes in from the north-west just at the shaft; this reef has the same characteristics as the other, viz., no defined course, and consisting of a series of short irregular bunches of stone, some of which are very good, and others no good at all. Two or three other small leaders have also been cut, but both these and the main one are so irregular, and so little work has been done upon them, that it is almost impossible to say what is their true course. The quartz in each of the reefs is white and glassy, and carries a considerable quantity of talc in cavities. The country is very soft kaolinised greenstone.

INGLISTON CONSOLS EXTENDED 475N.

Year.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average ozs. per ton.
1902	...	...	...
1903	59·25	267·65	4·51
Total	**59·25**	**267·65**	**4·51**

The following table shows the gold returns from the leases at Meekatharra, other than those already mentioned, up to the end of 1903:—

Name of Lease.	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom	Average ozs. per ton.
Albion	337N	25·00	10·20	·40
Blue Danube	252N	77·50	199·25	2·57
Calliope	450N	26·50	15·75	·59
Centaur	272N	99·00	88·12	·89
Halcyon North	318N	107·25	100·15	·93
Lost Cop	488N	56·00	21·75	·39
Phœnix No. 1	402N (373N)	144·33	142·93	·99
Phantom	416N	243·00	227·65	·94
Sirdar	246N	147·00	*207·51	1·41
Tidal Wave	411N	20·75	7·10	·34
(H. Brooking)	(unregistered)	18·75	7·40	·39
(Osborne and Campbell)	(unregistered)	19·75	11·95	·60
(Vollmer and party)	Q.P.P.A. 131N	7·00	4·40	·63
Sundry claims	...	171·50	217·05	1·26
Sundry parcels at public battery...	...	...	†86·65	...

* Includes 64·01ozs. dollied and specs. † By cyanide.

Abbotts.

The mining centre of Abbotts is situated about 40 miles to the north of Nannine. The country here is rough and hilly, the hills being of the usual type of greenstone and usually capped with a considerable thickness of ironstone gravel deposits, these being especially plentiful to the eastward of the townsite. These gravel beds (laterite) are often as much as 50ft. in thickness, but are of poor quality; they frequently contain caves of considerable size, in which are often found small deposits of an impure natural bitumen similar to that found at the Wilgie Mia* (Weld Range), Boogardie,† and other places on the Murchison Goldfield.

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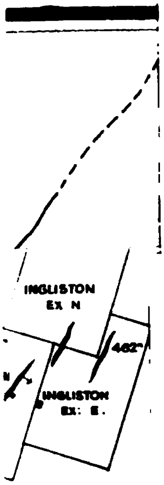
* *Vide* page 79. † Geological Survey, Bulletin 8, page 15.

Perth: By Authority: 1903.



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The greenstone belt is some ten miles in width, and is bounded on both sides by belts of granite, that on the western side running about north-east, and that on the east nearly north and south (*i.e.*, where seen, viz., at a point about due east of the townsite). Abbotts itself is situated in about the middle of this belt. A large number of quartz reefs run in all directions through the greenstone ridges to the east of the townsite, some of the outcrops being of considerable size, but having no length or regularity. The reefs which are being worked have a trend almost due north and south, extending in one case for over a quarter of a mile; they are not large, but are very regular and well-defined and run very nearly vertically.

Water is obtained at a depth of about 180ft., and is drinkable, but not good. At present most of the water for domestic purposes is obtained from the Government well, about three miles to the north of the townsite; the water level here is about 50ft. and the supply is excellent.

Mining operations were very quiet at Abbotts at the time of my visit (December, 1903), only two mines being worked, and one of these only in a very small way by a party of three tributers.

The Mines.

The following is a brief description of these two mines as far as I was able to examine them:—

MURCHISON KING G.M.L. 248N, 172N, ETC.—The main line of reef being worked on this property runs on an almost due north and south bearing through about the centre of the leases; it is of white quartz and is about two feet in width, bunching in places to as much as eight feet, with a dip of about 80° to the eastward, and can be followed on the surface for over a quarter of a mile; several shafts have been put down and a lot of work done on it. The main working shaft is down 300 feet, and drives have been put in from it at 200 and 300 feet, and one also at the 150-feet level from an underlay shaft six or eight chains south of the main shaft; this drive has been put in some 700 feet south and 250 feet north, and the reef stoped out to the surface for this length. A drive was also put in 200 feet farther south than this, at the 80 feet level, and this block taken out to the surface. A crosscut has also been put in from this underlay shaft at the 150-feet level for a distance of 275 feet westerly, to cut a second parallel reef. This reef is from 18 inches to two feet in width, and runs parallel to the main reef; between 500 and 600 feet of driving have been done on it, and the greater part of this length stoped out to the surface. From the main shaft the drive on the eastern reef at the 200-feet level is in 300 feet south and 600 feet north, and the whole of this block has been stoped out up to the 135-feet level; the drive at the 300-feet is in 250 feet south and 300 feet north, and this block has been stoped out up to the 200-feet level. At the time of my visit the bottom workings were flooded and I was only able to examine the 150 feet level; the reef here is very regular and for the most part maintains a uniform width of about two feet; a few larger sized bunches of stone occur here and there however. The country down to this level is very soft and broken. Intermediate between the main reef and the western one are several small parallel reefs up to a few inches in width; no work has, however, been done upon them.

The water supply of the mine is fresh.

New Murchison King G.M.Ls. 172N, 247N, 248N.

—	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Previous to 1897 ...	5·00	15·00	3·00
1897	990·00	1,042·65	1·06
1898	2,516·00	4,020·06	1·59
1899	1,430·00	1,574·05	1·10
1900	3,274·00	6,579·55	2·01
1901	2,551·00	3,732·55	1·46
1902	2,690·50	2,938·45	1·09
1903	2,445·00	1,461·75	·59
Total	**15,901·50**	**21,364·06**	**1·34**

Abbotts Proprietary G.M.L. 171N (Mt. Vranizan).—This mine was almost abandoned at the time of my visit, and as the lower workings were flooded I was unable to examine them. A good deal of work has been done on the property, and the reef has been worked out for a length of 400 feet down to the 400-feet level (on the underlay); a main vertical shaft has also been put down to a depth of 250 feet. The reef, which runs on a bearing slightly west of north and east of south, and dips to the westward at an angle of about 70°, is somewhat irregular, and varies from a few inches up to four feet; it is very much twisted and faulted, especially at the northern end; a considerable quantity of manganese is associated with the stone, especially at the points where it pinches.

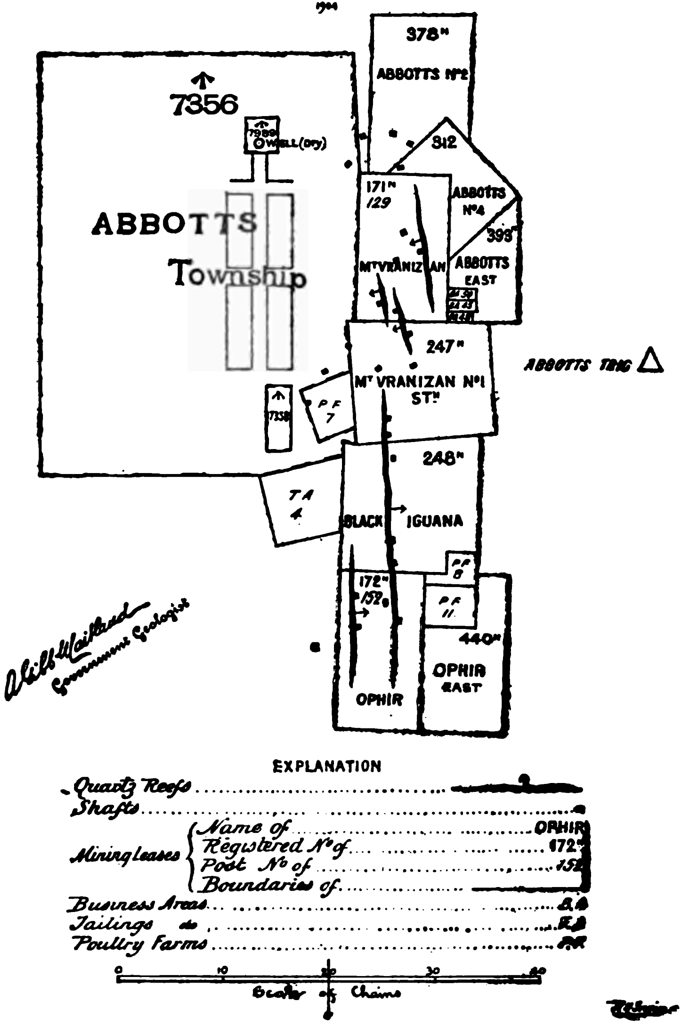
Several other smaller parallel reefs run through the property farther to the westward; the most easterly of these has had a little work done on it, but it was not much good.

The country consists of fine-grained greenstone, very soft in the upper workings, but hard and settled in the bottom level; the water supply is fresh.

At the time of my visit the property was in the hands of a small party of tributers, who were engaged principally in taking out small bodies of stone which had been left by the original company in the upper levels.

BULLETIN N° 14 PLATE IX.

MAP
OF THE AURIFEROUS QUARTZ REEFS
OF
ABBOTTS
MURCHISON G.F.
BY
C.G.Gibson
ASSISTANT GEOLOGIST
1904



A. Gibb Maitland
Government Geologist

Mt. Vranizan G.M.L. 171n.

—	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Previous to 1897 ...	372·00	277·00	·74
1897	...	...	...
1898	1,014·00	1,018·85	1·00
1899	3,030·00	3,328·95	1·09
1900	2,670·00	3,920·20	1·46
1901	1,058·00	1,118·10	1·05
1902	1,934·00	1,769·60	·91
1903	3,228·00	1,982·70	·61
Total ...	**13,306·00**	**13,415·40**	**1·01**

The following table shows the total gold returns from the leases at Abbotts, other than those already mentioned, up to the end of 1903:—

Name of lease	No. of Lease.	Tons of Ore treated.	Ozs. of Gold therefrom.	Average oz. per ton.
Cashman's Reward...	382n	128·50	184·60	1·43
White Horse ...	253n	58·50	65·00	1·11
Sundry claims ...	...	7·50	9·95	1·32

The Country between Nannine, Munarra Gully, and the Weld Range.

(Sixteen miles south-west and 35 miles west.)

The granite, which makes its appearance at Nannine townsite, continues for about eight miles, the country consisting principally of level plains covered with loose sandy soil, when its place is taken by low rough greenstone ridges, the junction of which, with the granite, runs apparently about north and south. These greenstone ridges continue unbrokenly to Munarra Gully. At a spot about a mile from their junction with the granite they are traversed by a series of parallel belts of hæmatite-bearing quartzites, which run in a north and south direction, and are apparently the northern continuation of those occurring at Stake Well.

For the first seven or eight miles after leaving Munarra Gully the track passes over low greenstone ridges with intervening flats, and then for a further distance of about eight miles over a belt of granite running north and south, and for the most part level, and covered with a shallow depth of loose sandy soil. After this comes a belt of greenstone schists about a mile in width, and then a second belt of granite similar to the preceding, and extending for a further distance of eight miles. From this point to the Weld Ranges the country is flat, and covered with a considerable thickness of loose reddish soil evidently derived from and overlying greenstones. The Weld Ranges are of massive greenstone, intersected by bands of hæmatite-bearing quartzites, and rise above the surrounding plains to a height of about 800 feet.

The Country between the Weld Range and Lake Austin.

(Forty miles south-south-east.)

From the Weld Ranges to about two miles from Cuddingwarra the country consists of level plains covered with the usual superficial deposits, these for the first seven miles overlying greenstones, and from that point onward overlying granite which occasionally rises through them in the form of low bare hills, especially in the neighbourhood of Coodardy Station. At Cuddingwarra the greenstones appear again in the form of low ridges extending for four or five miles, when they again give place to the plains which extend to near Day Dawn, where there are more greenstone ridges running about north and south and a couple of miles across. From this point to Lake Austin the level plains continue uninterruptedly.

The Iron Deposits of the Weld Range (the Wilgie Mia).

The Wilgie Mia is situated about five miles to the east of the Weld Hercules G.M. and some two miles south-west of Mt. Lulworth on a ridge running in an east and west direction along the south side of the Weld Range. The Wilgie Mia is of considerable interest owing to the occurrence of iron ores, which bid fair to become of some importance in the future. It has been thus described by Mr. H. P. Woodward, late Government Geologist, in his report on the Murchison Goldfield *:—

" In the Weld Range is situated the celebrated Wilgie Mia, which is certainly one of the most striking things to be seen in this colony. It is probably one of the largest iron lodes in the world, consisting almost entirely of hæmatite, which at the surface and in the cavities assumes the botryoidal form, which has given rise to the idea that it is a lava flow.

" It is situated on the east side of the Weld Range and runs east and west, dipping north, following the main strike of the rock.

" In these lodes there are soft bands, often clayey. These the kangaroos scratch out, forming caves, and it is probably in this way that the natives first made the discovery that this lode could be easily worked by following these beds. It has now been opened up as a huge pit or quarry to a depth of about 100 feet. This is entered, near the top of a hill 70 or 80 feet above the plain (400 feet. C.G.G.), by a hole about 50 feet across; then a steep descent commences over the talus in a south-easterly direction. At the bottom it spreads out to about 50 yards wide, with the roof some 60 feet above and numerous cave-like galleries running into the face in all directions.

"The Wilgie is worked by cutting round a mass of it, then wedging it off. This work, although very primitive, is very interesting, as these natives

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* The Murchison Goldfield, by H. P. Woodward, Government Geologist, page 20. Perth: By Authority, 1893.

work with their wooden tools much in the same manner as the ancient miners did in Great Britain with stone hammers. There are also rude attempts at staging to allow the miners to work up into the roof when veins of sufficiently good quality run that way. In contemplating this pit one is struck by the vastness of the work, and when we consider the small quantity of Wilgie that can be required it must have been worked for centuries. Of course it was worked on a much larger scale before the white invasion of Western Australia and was probably traded great distances.

"As far as the lode itself is concerned, it is most magnificent iron ore, and considering its size will, without doubt, be of great value in the future.

"It has been generally supposed that cinnabar existed here associated with volcanic rocks; but there is nothing of the sort, the Wilgie itself being red hæmatite and red and yellow ochre."

The deposit, which is of almost pure hæmatite, is, roughly, some 150 feet to 200 feet in width, and forms a ridge about three miles in length, rising in places to a height of 400 feet above the plain. The deposit is undoubtedly of similar origin to the hæmatite-bearing quartzites which form the main axis of the Weld Range, and which are so prevalent throughout the whole of the Murchison Goldfield, the only difference being that in this case silica is almost entirely absent and the lode is composed of almost pure hæmatite, with magnetite and limonite, resulting from the gradual replacement of greenstone schists by iron-bearing solutions.

The dip of the lode is very nearly vertical. As sulphides are not likely to be met with above water level—which is about 60 feet below the surface of the plain—it will be thus seen that there is an immense body of very high grade iron ore here (*vide* analyses).

A second somewhat similar deposit is said to exist about two miles to the north-eastward of Mt. Lulworth. Several samples of ore shown me from this locality were in appearance of the same quality as [5356]; owing, however, to the dryness of the season and lack of horse feed, I was unable to stay long enough to examine this deposit.

These deposits, which are undoubtedly some of the richest in the world, are at present rendered practically valueless owing to their inaccessibility and distance from a suitable coalfield.

In the tunnels and caves in the sides of the Wilgie Mia are found considerable deposits of an impure natural bitumen [5361]; this, from its general appearance and mode of occurrence, I am inclined to think is only a decomposition product of the excreta of bats and wallabies.

The following are three partial analyses of samples of iron ore from the Wilgie Mia, and one also of a sample [5360] of hæmatite-bearing quartzite from the Weld Range:—

Analyses—	I.	II.	III.	IV.	
Metallic iron ...	63·87 ...	64·36 ...	68·83 ...	35·50	per cent.
Silica	2·48 ...	1·38 ...	1·00 ...	43·42	„
Phosphorus ...	·090 ...	·052	small trace	·089	„
Sulphur ...	·033 ,..	·023 ...	·035 ...	·036	„
Water (hyg.)...	·89 ...	·57 ...	·19 ...	·15	„
Water (combined)	1·52 ...	·60 ...	·35 ...	4·17	„

Traces only of titanium were present in these samples.

***Localities*—**

I. is from what is known as the Little Wilgie Mia, about one and a-half miles west of the Wilgie Mia and on the same lode; it represents a sample taken across about 20 feet of the lode at a depth of about 15 feet from the surface.

II. is from the Wilgie Mia, and is a sample taken across a face of the lode about 150 feet in width and at a depth of about 100 feet from the surface (*i.e.*, from the top of the hill).

III. [5356] is a picked sample of ore from a surface boulder at the Wilgie Mia; there are, however, a good many thousands of tons of this class of ore on the surface.

IV. [5360] is a typical sample of the hæmatite-bearing quartzites which traverse the Weld Range from end to end, and is from a spot about three-quarters of a mile west of the Weld Hercules G.M.

Samples I., II., and III. represent very rich hæmatite ores, extremely low in sulphur and silica and free from titanium. The phosphorus percentage in I. is somewhat above the Bessemer limit; pig iron smelted from it would, however, make good stock for the production of "basic" steel. The phosphorus percentage in sample II. is just about the permissible limit for the cheaper Bessemer process; but sample III. is extremely pure and low in phosphorus, and as there is a considerable quantity of this quality of ore present, the whole deposit, if it is ever worked, will probably prove of such grade as to permit of the use of this process of steel manufacture. Regarding the probable quantity of ore present, an estimate has been made of the amount in sight as, roughly, 26½ million tons. To obtain these figures the length of the deposit has been taken as three miles, the average width as 150 feet, and the average height of the cap of the lode above the plain to be 100 feet, all of which dimensions are, if anything, a long way on the safe side; taking the weight of a cubic foot of the ore to be 250lbs., this gives the amount of ore actually above the level of the surrounding plains to be as above stated, roughly, 26½ million tons. In addition to this deposit, there are the hæmatite-bearing quartzites which traverse the Weld Range from end to end, and of which IV. [5360] is a typical sample. These deposits, of which there is practically an inexhaustible supply, and amongst which there are said to be other rich patches similar to the Wilgie Mia deposit,* though of rather too low grade for smelting purposes as they now exist, could, with the employment of suitable concentrating machinery, be converted into first-class ores, and during this process of concentration would doubtless lose a considerable portion of their phosphorus contents. These remarks also apply to the hæmatite-bearing quartzites found in such large quantities all over the Murchison goldfield, several analyses of which are given in this report and which, as far as sampled at present, may be said to average from 30 to 40 per cent. of metallic iron. With regard to the probability of these ores living to a depth, similar deposits (of hæmatite-bearing quartzites) have been proved to exist to a vertical depth of 250 feet at Boogardie and Lake Austin, apparently without any change in their mineral constitution beyond a slightly increased sulphur percentage.

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* *Vide* page 79.

The Titaniferous Iron Deposits of Gabanintha.

As mentioned on page 46, there is a large deposit of titaniferous magnetite about half way between Gabanintha and Star of the East. As shown by the analysis of a typical sample given on the same page, this is, except for the presence of the titanium, an extremely pure ore, sulphur and phosphorus both being almost entirely absent.

The deposit extends over a length of about two miles and varies in width from 50 to 100 feet, rising in places to over 60 feet above the surrounding country; taking it as having an average width of 50 feet, an average height of 25 feet above the plain, and a length of two miles, this gives, roughly, one and a-half million tons as the quantity of ore actually above the surface of the ground.

The high percentage of titanic acid in this will always tend to preclude its being worked profitably, although this is a difficulty which at the present time is being rapidly overcome.

With regard to the smelting of titaniferous iron ores, the following extract is taken from Mr. J. B. Jaquet's report on the iron ores of New South Wales:—[*]

> **According to Mr. T. Turner, titanferous iron ores are difficult to smelt owing to the formation of cyano-nitride of titanium, which collects in the hearth of the furnace. [†] Many years ago a company—the Norwegian Titanic Iron Company—was formed for the purpose of smelting, without mixture of other ores, ilmenite obtained from Norway. Mr. W. M. Bowron, who was employed as chemist by the company, says, concerning their operation, as follows:—[‡]" The process, regarded as a process, was a perfect success; but the enormous quantity of fuel required, the small quantity of iron in the ore, and the cost and uncertainty of importation militated seriously against its commercial success, and a few years saw the attempt abandoned." After describing the process in detail, Mr. Bowron says:—" If, then, the use of titaniferous ores involves extra fuel, low heats and slow driving, and makes white iron, what is the inducement to use them? I can only answer that for ordinary use they are wholly unsuitable; but for making a forge iron that has brought double the market price of common iron, for use as a mixture to impart the property of cold toughness to other iron, or for making an iron to be mixed with other irons that are not quite up to requirements for boiler plates, for blooms, or for an extra good iron generally, these ores are most valuable." It has been found that titanic acid requires a greater heat for its reduction as compared with oxide of iron, and so, when smelting titaniferous iron ores, it is important that the temperature of the furnace should be kept as low as possible, in order that the titanic acid may pass on unaltered into the slag.**
>
> **The question of smelting titanic ores has been discussed by Mr. A. T. Rossi. [§] He says that American ironmasters have generally thought that mixtures containing more than 1·25 per cent. of titanium could not be smelted on account of the tendency which this element has to make the slag pasty. Ores containing 5 to 10 per cent., or even 15 to 20 per cent., have been smelted in Norway when the fluxes have been so chosen as to produce a slag approximating in composition to certain natural compounds of titanium, such as sphene. In a letter to the *Engineering and Mining Journal*, Mr. Rossi cites many opinions favourable to the employment under certain circumstances of pig iron produced from titaniferous ores[||].**

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[*] " The Iron Ore Deposits of New South Wales," by J. B. Jaquet, F.G.S., pages 81, 82. Geol. Surv. of N.S.W. Sydney: By Authority, 1901.

[†] The Metallurgy of Iron, by T. Turner, page 53.

[‡] Trans. Am. Inst. Min., Eng., 1882. XI., p. 159.

[§] Journ. of Am. Chem. Soc., 1890, p. 91.

[||] Eng. and Min. Journal, 10 Mar., 1900, p. 284

Other Iron Deposits of the Murchison Goldfield.

The following extracts are taken from a report by the Government Geologist, appearing in the Annual Report of the Geological Survey for the year 1902*, and are inserted in this place, referring as they do to the ores of the Murchison :—

The iron deposits of the State, so far examined, can be broadly separated into two main divisions—

(*a*.) The ores associated with the crystalline schists and other allied rocks ; and

(*b*.) The superficial deposits of limonite (laterite ore) which occupy extensive areas in many and widely-separated portions of the State, and the soft porous deposits of hydrated oxide or iron (bog ore) of comparatively recent origin. . . .

The important ores associated with the crystalline schists are developed most extensively in the watershed of the Murchison River, more especially between 25 degrees and 28 degrees south latitude and 116 and 119 degrees east longitude. . . . These deposits consist of highly-inclined beds, bands and lenses of almost pure hæmatite (occasionally magnetite) or admixtures in all proportions of hæmatite and quartz. . . .

The sigma-shaped range of hills on the west side of the Murchison, of which Mts. Taylor, Hale, Matthew, Yarrameedie, and Erawandoo form the most prominent summits, is remarkably prolific in iron-bearing schists. The summit of Mt. Hale is formed of contorted quartz schists with bands of hæmatite, which occur in the lenticular masses; some bands are often as thin as a sheet of paper, whilst others widen out to considerable dimensions. One band measured 70 feet across, and outcropped for over a quarter of a mile, but varied in thickness in different parts. There were similar bands parallel to it, and equally persistent along the strike. Just under the western summit of Mt. Hale the quartzite is replaced by a great bed of hæmatite, several huge monoliths of which stand out prominently on the range. This hæmatite can be followed along the range to a point just south of the summit of Mt. Matthew. A partial analysis made in the Departmental Laboratory of a sample of this bed gave results as follows :—

Ferric oxide Fe_2O_3	... ...	94·05 per cent.
Ferrous oxide FeO	... ...	0·97 ,,

equal to 66·59 per cent. of metallic iron.

The outcrop of a bed of ironstone forms a conspicuous feature on the surface at the foot of the Mount Narryer Range. The bed, which is vertical, attains a thickness of eight or nine feet, and rises about two feet above the ground.

The following table shows the position of the Murchison deposits with reference to the nearest coalfield on the Irwin River, and the means of transport thereto :—

Deposit.	Distance from nearest seaport by rail and road.	Distance from railway line.	Distance from nearest coalfield by rail and road.
Mt. Hale	362 miles, Geraldton	100 miles, Cue ...	441 miles, Irwin River
Mt. Narryer	362 ,, ,,	100 ,, ,, ...	441 ,, ,,
Wilgie Mia	312 ,, ,,	50 ,, ,, ...	391 ,, ,,
Gabanintha	332 ,, ,,	20 ,, Nannine	411 ,, ,,

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* The Iron Deposits of Western Australia, by A. Gibb Maitland, Government Geologist. Annual Progress Report of the Geol. Survey for the year 1902, page 8. Perth : By Authority, 1903.

Appendix I.

List of Specimens collected in North Murchison District.

Registered No. of Specimen.	Registered No. of Microscope Slide.	Name of Specimen.	Locality.	Remarks.
5316	460	Amphibolite	30 chains W. of Boyd's Reward G.M.L. 64N, Tuckanarra	*See* page 27
5317	461	Diorite (quartz diorite)	30 chains S.W. of Boyd's Reward G.M.L. 64N, Tuckanarra	*See* page 27
5318	462	Granite (granite aplite)	5 chains E. of G.M.L. 140N, Tuckanarra	*See* page 28
5319	...	Hæmatite-bearing quartzite	G.M.L. 80N, Tuckanarra	
5320	...	Do. do.	Telegraph line, 8¼ miles N.E. from Tuckanarra	
5321	...	Do. do.	Near Cable G.M.L. 282, Tuckanarra	
5322	...	Do. do.	40 chains E of Maybelle G.M.L. 1270, Tuckanarra	
5323	...	Do. do.	do. do. do.	
5324	...	Do. do.	Telegraph line, 8¼ miles N.E. from Tuckanarra	For analysis, *see* page 28
5325	...	Do. do.	do. do. do.	
5326	...	Do. do.	200-mile peg, telegraph line, Tuckanarra	
5327	...	Do. do.	Telegraph line, 8¼ miles N.E. from Tuckanarra	For analysis, *see* page 28
5328	...	Do. do.	100-feet level, Bachelor G.M., Tuckanarra	
5329	463	Amphibolite (diorite ?)	5 chains N. of G.M.L. 453N, Quinns	*See* page 40
5330	...	Hæmatite-bearing quartzite	15 chains N. of G.M.L. 453N, Quinns	
5331	...	Do. do.	Sir Garnet G.M.L. 23, Quinns	For analysis, *see* page 41
5332	..	Asbestos (impure)	10 chains S.W. of G.M.L. 478, Quinns	
5333	464	Granitic schist	G.M.L. 467, Quinns	*See* page 40
5334	473	Basic tuff	Summit of Mt. Yagahong, Gabanintha	*See* page 44
5335	474	Do.	Half-way up Mt. Yagahong, Gabanintha	
5336	465	Amphibolite	Sovereign G.M.L. 397, Gabanintha	*See* page 45
5337	...	Copper ore	Mountain View G.M.L. 379, Gabanintha	

LIST OF SPECIMENS COLLECTED IN NORTH MURCHISON DISTRICT—*continued.*

Registered No. of Specimen.	Registered No. of Microscope slide.	Name of Specimen.	Locality.	Remarks.
5338	...	Copper ore (chrysocolla)	G.M.L. 340, Gabanintha	For analysis, *see* page 48
5339	...	Sulphide copper ore	do. do.	
5340	...	Copper ore	M.L. 1N, Gabanintha	
5341	...	Asbestos	do. do.	*See* page 48
5342	...	Calcite	Star of the East G.M.L. 344, Gabanintha	
5343	466	Granitite (granophyre)	Star Extd. G.M.L. 241, Gabanintha	*See* page 46
5344	...	Magnetite	40 chains E.N.E. of G.M.L. 241, Gabanintha	For analysis, *see* page 46
5345	467	Granite	40 chains N.E. of G.M.L. 32N, Gabanintha	*See* page 45
5347	...	Hæmatite-bearing quartzite	40 chains N. of Daisy G.M.L. 457, Nannine	
5348	468	Felsite	30 chains N. of Daisy G.M.L. 457, Nannine	*See* page 56
5349	469	Hornblende granite	G.M.L. 115N, Nannine	*See* page 55
5350	470	Altered pyroxenite	Champion G.M.L. 17N, Nannine	*See* page 54
5351	471	Hornblende granite	G.M.L. 13N, Nannine	*See* page 56
5352	...	Hæmatite-bearing quartzite	30 chains S. of G.M.L. 249, Nannine	For analysis, *see* page 55
5353	...	Do. do.	1 mile N.E. from 21-mile peg, Meekatharra	
5354	472	Granite (biotite granite ?)	1 mile N. of Havelock G.M.L. 236, Meekatharra	*See* page 61
5355	...	Iron ore (hæmatite)	1¼ miles W. of Wilgie Mia, Weld Range	For analysis, *see* page 79
5356	...	Do. do.	Wilgie Mia, Weld Range	For analysis, *see* page 79
5357	...	Do. do.	do. do.	
5358	...	Do. do.	do. do.	
5359	...	Do. do.	do. do.	
5360	...	Hæmatite-bearing quartzite	¾-mile W. of Weld Hercules G.M., Weld Range	For analysis, *see* page 79
5361	..	Natural bitumen	Wilgie Mia, Weld Range	*See* page 79
5362	...	Copper ore	After Many Years G.M.L., Munarra Gully	
5363	...	Gold in quartz	Boyd's Reward G.M., Tuckanarra	
3796	258	Grano-diorite	Agamemnon G.M., Cue	*See* page 14
3832	...	Norite	From hill between Lady Forrest and Polar Star G.M., Cue	*See* page 15

3823	...	Amphibolite	9 chains S. of Princess Extended G.M.L. 1232, Cue	*See* page 15
3847	...	Do.	Water reserve 7745, Cue	*See* page 15
3976	...	Felspar porphyry	2,030ft. level; D.D. bore on G.M.L. 226, Day Dawn	*See* page 15
5106	344	Diorite	Mainland Consols G.M.L. 171, Lake Austin	
5107	...	Hæmatite-bearing quartzite ...	N.E. of Ingot G.M.L. 204, Lake Austin	
5108	345	Diorite	G.M.L. 765, Lake Austin	
5109	...	Hæmatite-bearing quartzite ...	North end of Island, Lake Austin	For analysis, *see* page 19
.5110	...	Do. do. ...	do. do.	For analysis, *see* page 19
5111	343	Diorite	20 chains N.W. of G.M.L. 234, Island Lake Austin	
5112				

CHAS. G. GIBSON, B.E.,
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